VISHAY INTERTECHNOLOGY, INC.

INTERACTIVE
data book

SMD • RADIAL • AXIAL ALUMINUM CAPACITORS

VISHAY

VSE-DB0111-0810

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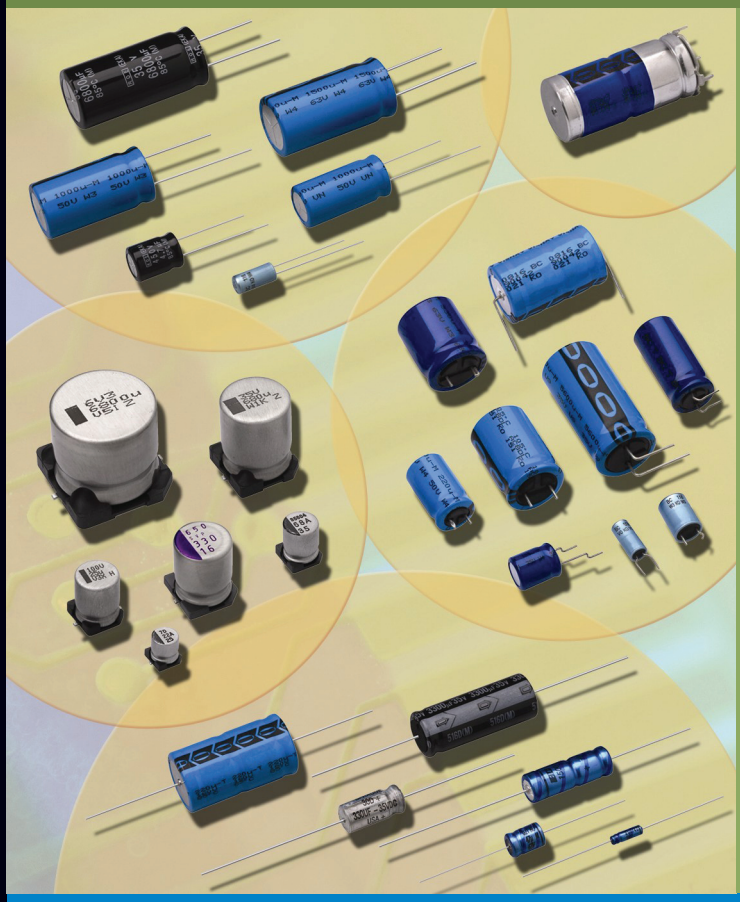

DATA BOOK

SMD · RADIAL · AXIAL
ALUMINUM CAPACITORS

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SEMICONDUCTORS

RECTIFIERS
- Schottky (single, dual)
- Standard, Fast, and Ultra-Fast Recovery (single, dual)
- Bridge
- Superectifier®
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RESISTIVE PRODUCTS
- Foil Resistors
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  - Thick Film Resistors
  - Metal Oxide Film Resistors
  - Carbon Film Resistors
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- Power Metal Strip® Resistors
- Chip Fuses
- Variable Resistors
  - Cermet Variable Resistors
  - Wirewound Variable Resistors
  - Conductive Plastic Variable Resistors
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- Non-Linear Resistors
  - NTC Thermistors
  - PTC Thermistors
  - Varistors

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- Transformers

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  - Molded Chip Tantalum Capacitors
  - Coated Chip Tantalum Capacitors
  - Solid Through-Hole Tantalum Capacitors
  - Wet Tantalum Capacitors
- Ceramic Capacitors
  - Multilayer Chip Capacitors
  - Disc Capacitors
- Film Capacitors
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SMD . RADIAL . AXIAL
Aluminum Capacitors

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SMD . RADIAL . AXIAL
Aluminum Capacitors

GENERAL

VISHAY BCcomponents

VISHAY ROEDERSTEIN

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Large and Screw Terminal (VSE-DB0078-0810)	L & S

SMD · RADIAL · AXIAL
Aluminum Capacitors

Vishay BCcomponents

REPLACEMENT SERIES TABLE			
MATURED SERIES	**DESIGN**	**REMARK**	**REPLACEMENT SERIES**
048 CLB	SMD	General Purpose, 105 °C	153 CRV
085 CS	SMD	Horizontal SMD, 85 °C	153 CRV
136 CLB	SMD	Low Impedance, 105 °C	150 CRZ
139 CLL	SMD	Horizontal SMD, 105 °C	153 CRV
140 CLH	SMD	High Temperature, 125 °C	140 CRH
150 CLZ	SMD	Low Impedance, 105 °C	150 CRZ
153 CLV	SMD	General Purpose, 105 °C	153 CRV
165 CLB	SMD	High Temperature, 125 °C	140 CRH
172 CLP	SMD	Horizontal SMD, 85 °C	153 CRV
176 SAL	SMD	Solid Aluminum	175 TMP
034 RS	Radial	General Purpose, 85 °C	038 RSU
035 RS	Radial	General Purpose, 85 °C	038 RSU
037 RSM	Radial	General Purpose, 85 °C	038 RSU
044 RSH	Radial	General Purpose, HV, 85 °C	152 RMH
045 RSS	Radial	General Purpose, 105 °C	048 RML
046 RSL	Radial	Low Impedance, 105 °C	048 RML
047 RMS	Radial	General Purpose, 105 °C	148 RUS
135 RLI	Radial	Low Impedance, 105 °C	150 RMI, 136 RVI
151 RLH	Radial	General Purpose, HV, 105 °C	152 RMH
164 RSX	Radial	Long Life, 105 °C	150 RMI, 136 RVI
165 RHT	Radial	High Temperature, 125 °C	140 RTM
122 SAL-RP	Radial	Solid Aluminum	128 SAL-RPM
124 SAL-RQ	Radial	Solid Aluminum, Boxed	128 SAL-RPM
129 SAL-RDC	Radial	Solid Aluminum, Low Leakage	128 SAL-RPM
014 ALZ	Axial	Low Impedance	021 ASM
015 AS	Axial	General Purpose, 85 °C	021 ASM
016 AS	Axial	General Purpose, 85 °C	021 ASM
017 AS	Axial	General Purpose, 85 °C	021 ASM
022 ASR	Axial	General Purpose, 105 °C	138 AML
023 ASR	Axial	General Purpose, 85 °C	021 ASM
024 AMR	Axial	Miniaturized, 105 °C	138 AML
025 AMR	Axial	Miniaturized, 85 °C	021 ASM
026 ACR	Axial	General Purpose	138 AML, 041-043 ASH
027 ACR	Axial	General Purpose	138 AML, 041-043 ASH
032/033 AS	Axial	General Purpose, 85 °C	021 ASM
039 ABP	Axial	Bipolar	137 ABA, 137 92 AB
042/043 ASH-ELB	Axial	Lighting Ballast Standard	042-043 AHH-ELB, 042-043 AMH-ELB
049 ASC	Axial	General Purpose, 85 °C	021 ASM
065 ALC	Axial	Low Leakage, 85 °C	021 ASM
108 ALL-IEC	Axial	Long Life, 85 °C	132 ALL-DIN, 138 AML
133 ALL-DIN	Axial	Ø 10 x 30 to 21 x 40 mm only	041-043 ASH
121 SAL-A	Axial	Solid Aluminum	123 SAL-A

Vishay Roederstein

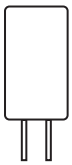
REPLACEMENT SERIES TABLE			
MATURED SERIES	**DESIGN**	**REMARK**	**REPLACEMENT SERIES**
ECB	SMD	General Purpose, 105 °C	ECV
EKM	Radial	General Purpose, 105 °C	EKE, 116 RLL, 048 RML
EKO	Radial	General Purpose, 85 °C	EKA
EKR	Radial	General Purpose, 105 °C	EKE
EKS	Radial	General Purpose, 105 °C	EKB
EBV/EGV (-D)	Axial	Lighting Ballast	042-043 AHH-ELB
EGU	Axial	Bipolar	no replacement
EGT	Axial	Bipolar	no replacement
EGW	Axial	Bipolar	no replacement
ELM/EBM/EGM	Axial	Miniaturized, 85 °C	021 ASM
EL/EB/EG	Axial	General Purpose	030/031 AS, 041 ASH, 117 ASD
EBU	Axial	Bipolar	137 ABA, 137 92 AB
EBT	Axial	Bipolar	137 ABA, 137 92 AB
EBC/EGC	Axial	General Purpose	132/133 ALL-DIN
EBR	Axial	General Purpose	030/031 AS
EBL/EGL	Axial	Higher Temperature	118 AHT

Vishay Sprague

REPLACEMENT SERIES TABLE			
MATURED SERIES	**DESIGN**	**REMARK**	**REPLACEMENT SERIES**
673D	Radial	General Purpose, 105 °C	U673D
674D	Radial	General Purpose, 105 °C	U674D
757D	Radial	Low Impedance, 105 °C	150 RMI, EKE

Radial and SMD Series

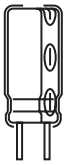
RADIAL SERIES



all-insulated lead pitch 2.5 or 5.0 mm	
85 °C	105 °C
013 RLC **036 RSP**	**116 RLL**

high temperature, solid electrolyte
125 °C
128 SAL-RPM

high temperature
125 °C
140 RTM **EKL** **510D**



non polarized
105 °C
EKSU

standard ranges	
85 °C	105 °C
038 RSU **EKA** **515D**	**148 RUS** **EKB** **511D** **517D** **678D** **757D** **U673D** **U674D**

low leakage	
85 °C	105 °C
013 RLC	**EKI**

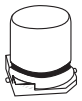
long life, low Z, high ripple current
105 °C
048 RML **152 RMH** **136 RVI** **150 RMI** **EKE** **EKX** **EKV** **672D**

low impedance, organic electrolyte
105 °C
94 SA **94 SC** **94 SL** **94 SH** **94 SS** **94 SP**

low profile
85 °C
134 RLP-5 **097 RLP-7**

double layer
196 DLC

SMD SERIES



high temperature, solid electrolyte
175 °C
175 TMP

standard ranges	
85 °C	105 °C
ECA	**153 CRV** **ECV**

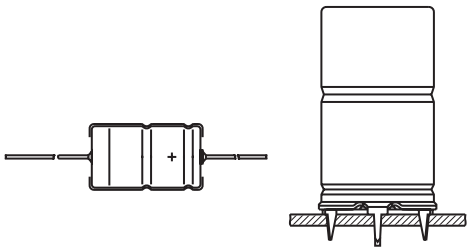
high temperature
125 °C
140 CRH

low impedance
105 °C
150 CRZ **ECL**

low impedance, organic electrolyte
105 °C
94SVP

low impedance, organic electrolyte
125 °C
94SVPD

Axial Series



standard ranges	
85 °C	105 °C
021 ASM **030/031 AS** **041 - 043 ASH** **132/133 ALL-DIN** **TVA ATOM®** **39D** **53D** **500D** **516D**	**138 AML** **TE** **601D** **30D**

miniature diameter 3.3 mm
85 °C
117 ASD

non polar
105 °C
EBU/EBT on request

non polar
125 °C
610D

for lighting ballast	
85 °C	105 °C
042-043 AMH-ELB	**042-043 AHH-ELB**

high temperature, solid electrolyte
125 °C
123 SAL-A

high temperature
125 °C
118 AHT **119 AHT-DIN** **630D** **600D**

high temperature, low impedance
125 °C
120 ATC

4 terminal
105 °C
604D

Vishay BCcomponents

Contents

Aluminum Capacitors

TRANSLATION OF TECHNICAL TERMS		
SOME IMPORTANT TERMS	**DES TERMES IMPORTANTES**	**EINIGE WICHTIGE BEGRIFFE**
Ambient temperature (T_{amb})	température ambiante	Umgebungstemperatur
Assessment level	niveau d'assurance	Gütebestätigungsstufe
Axial terminations	sorties axiales	axiale Anschlußdrähte
Capacitance	capacité	Kapazität
Charge	charge	laden
Climatic category	catégorie climatique	Klimakategorie
Dimensions	dimensions	Maße
Discharge	décharge	entladen
Dissipation factor (tan δ)	tangente de l`angle de pertes	Verlustfaktor
Endurance	endurance	Dauerspannungsprüfung
Equivalent series resistance (ESR)	résistance série équivalente	äquivalenter Serienwiderstand
Equivalent series inductance (ESL)	inductance série équivalente	äquivalente Serieninduktivität
Failure rate	taux de fiabilité	Ausfallrate
Frequency (f)	fréquence	Frequenz
General purpose grade	usage général	allgemeine Anforderungen
Impedance (Z)	impédance	Scheinwiderstand, Impedanz
Leadless	sans fils	unbedrahtet
Leakage current (I_l)	courant de fuite	Reststrom
Long life grade	longue durée de vie	erhöhte Anforderungen
Method	méthode	Verfahren
Mounting	montage	Montage
No visible damage	aucun dommage	keine sichtbaren Schäden
Open circuit	circuit ouvert	Unterbrechung
Mounting hole diagram	dessin de montage	Bohrungsraster
Rated capacitance (C_R)	capacité nominale	Nennkapazität
Rated voltage (U_R)	tension nominale	Nennspannung
Recovery	reprise	Nachbehandlung
Forming voltage (U_F)	tension de formation	Formierspannung
Requirements	exigences	Anforderungen
Reverse voltage (U_{rev})	tension inverse	Umpolspannung
Ripple current (I_R)	courant ondulé	überlagerter Wechselstrom
Short circuit	court-circuit	Kurzschluß
Surface mounting device (SMD)	composant pour montage en surface	oberflächenmontierbares Bauelement
Surge voltage (U_S)	surtension	Spitzenspannung
Terminal pitch	distance entre les connections	Rastermaß
Terminations	sorties	Anschlüsse
Useful life	durée de vie	Brauchbarkeitsdauer
Visual examination	examen visuel	Sichtkontrolle

CAPACITOR PRINCIPLES

The essential property of a capacitor is to store electrical charge. The amount of electrical charge (Q) in the capacitor (C) is proportional to the applied voltage (U).
The relationship of these parameters is:

$$Q = C \times U$$

where:

Q = charge in coulombs (C)
C = capacitance in farads (F)
U = voltage in volts (V)

The value of capacitance is directly proportional to the (anode) surface area and inversely proportional to the thickness of the dielectric layer, thus:

$$C = \varepsilon_0 \times \varepsilon_r \times \frac{A}{d}$$

where:

ε_0 = absolute permittivity (8.85×10^{-12} F/m)
ε_r = relative dielectric constant (dimensionless)
A = surface area (m^2)
d = thickness of the dielectric
(oxide layer in aluminum capacitors) (m).

ENERGY CONTENT OF A CAPACITOR

The energy content of a capacitor is given by:

$$W_E = \frac{1}{2} \times (C \times U^2)$$

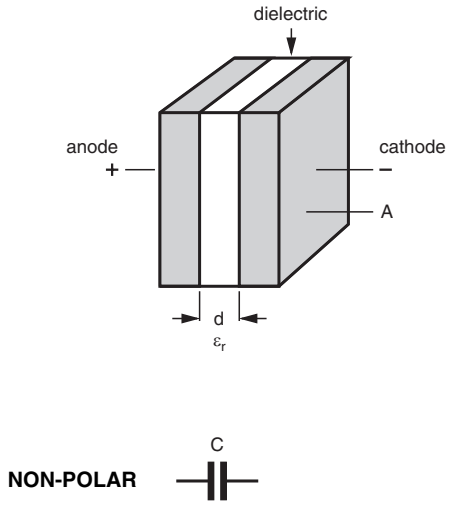
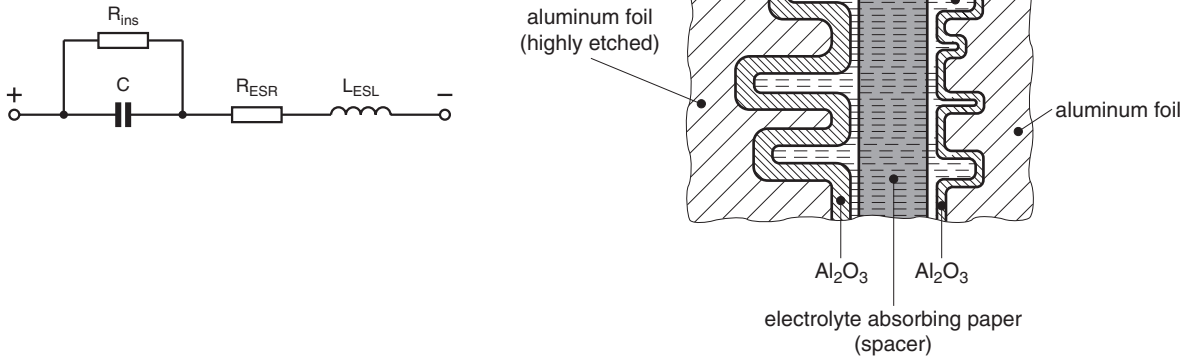


Fig.1 Equivalent circuit of an ideal capacitor



POLAR

Anode electrode: valve effect metal: aluminum.

Dielectric: Al_2O_3
Cathode electrode, solid or non-solid electrolyte depending on technology:

non-solid: wet electrolyte, spacer and aluminum foil

solid: solid electrolyte (e.g. manganese dioxide), graphite and silver epoxy

Fig.2 Equivalent circuit of an aluminum capacitor

ELECTRICAL BEHAVIOR

Characteristics of aluminum capacitors vary with temperature, time and applied voltage.

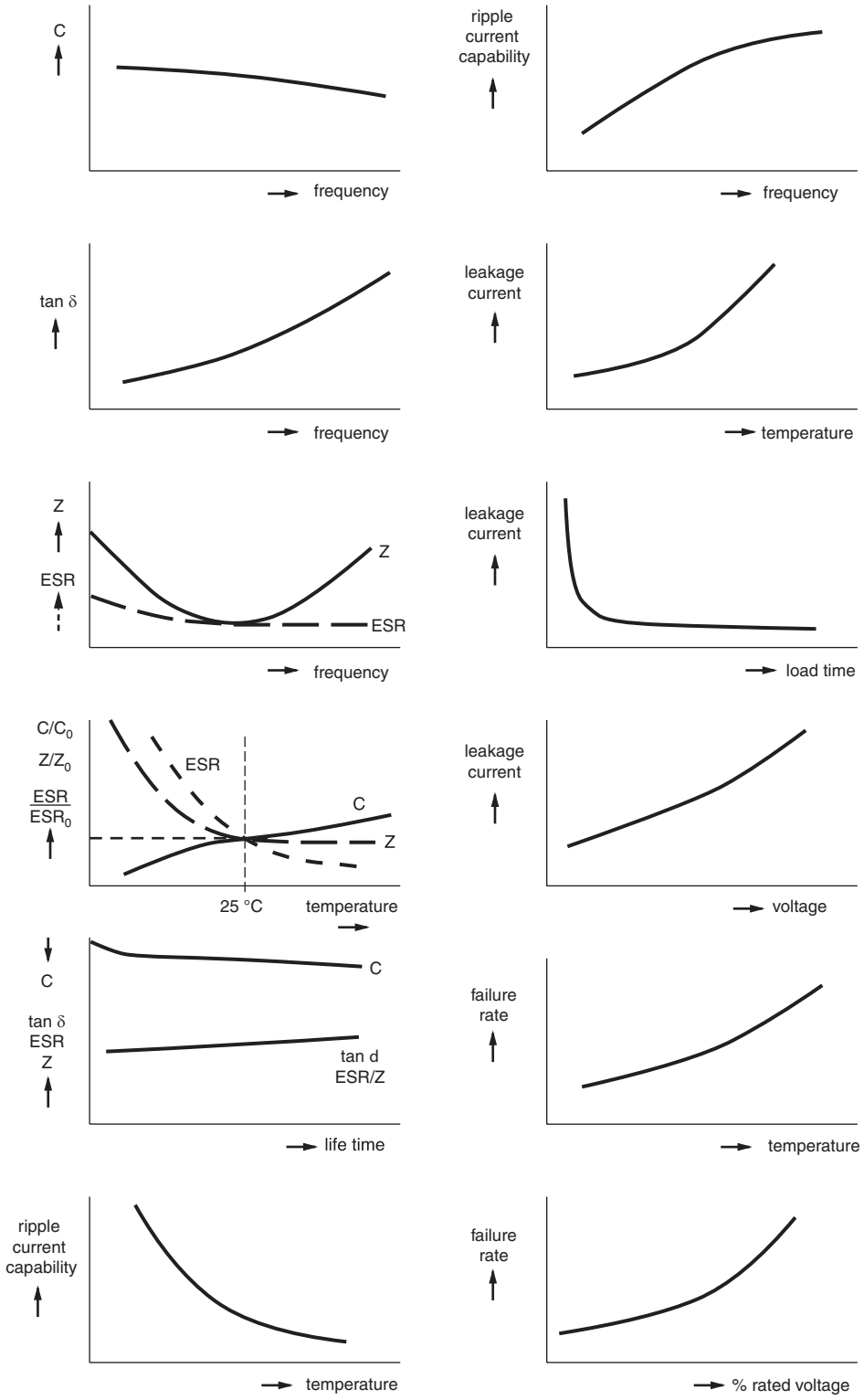


Fig.3 Typical variation of electrical parameters as a function of frequency, ambient temperature, voltage and time

CONSTRUCTION

Examples

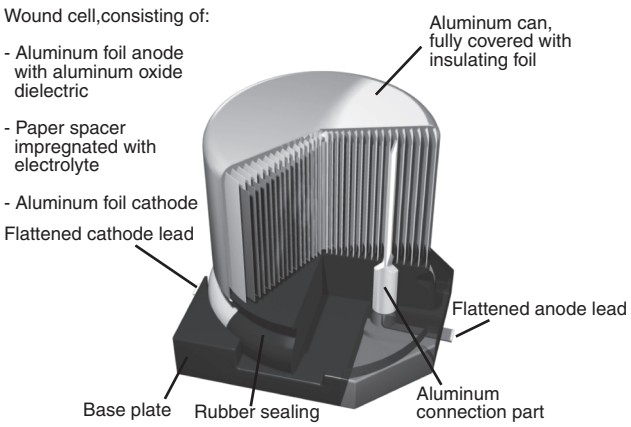


Fig.4 Surface Mount Device (vertical style)

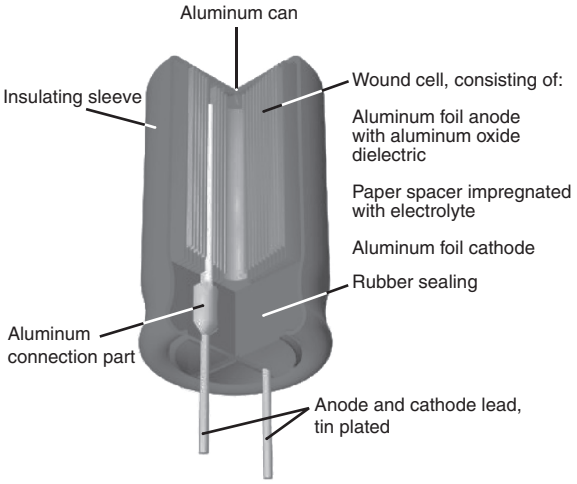


Fig.5 Radial Aluminum

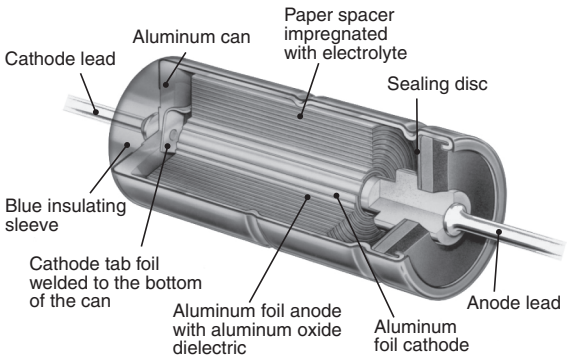


Fig.6 Axial Aluminum

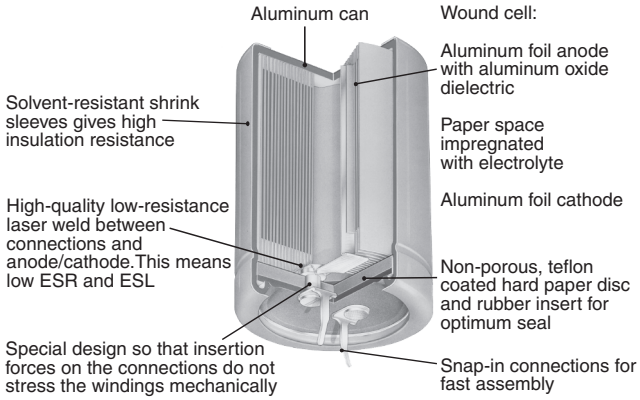


Fig.7 Large Aluminum, snap-in

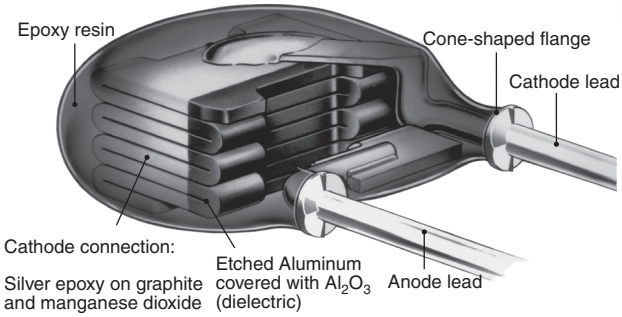


Fig.8 Solid Aluminum (SAL), radial

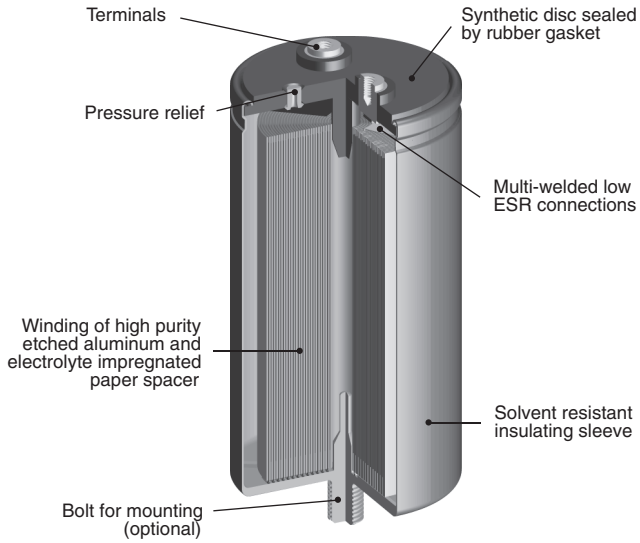


Fig.9 Large Aluminum, screw terminal

DEFINITIONS OF ELECTRICAL PARAMETERS

Sequence of measurement for tests are in accordance with "*IEC 60384-4*":

1. Leakage current (I_L)
2. Capacitance (C_R)
3. Dissipation factor (tan δ or ESR)
4. Impedance (Z)

CAPACITANCE

AC CAPACITANCE OF AN ALUMINUM CAPACITOR

The capacitance of an equivalent circuit, having capacitance, resistance and inductance in series, measured with alternating current of approximately sinusoidal waveform at a specified frequency; refer to Fig.10.

Standard measuring frequencies for aluminum capacitors are 100 Hz or 120 Hz

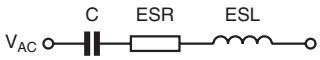


Fig.10 AC equivalent circuit of an aluminum capacitor

DC CAPACITANCE OF AN ALUMINUM CAPACITOR (FOR TIMING CIRCUITS)

DC capacitance is given by the amount of charge which is stored in the capacitor at the rated voltage (U_R).
DC capacitance is measured by a single discharge of the capacitor under defined conditions. Measuring procedures are described in "*DIN 41328, sheet 4*" (withdrawn).

At any given time, the DC capacitance is higher than the AC capacitance.

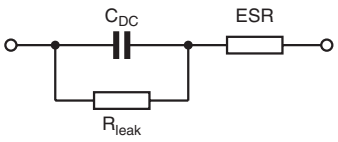


Fig.11 DC equivalent circuit of an aluminum capacitor

RATED CAPACITANCE (C_R)

The capacitance value for which the capacitor has been designed and which is usually indicated upon it.

Preferred values of rated capacitance and their decimal multiples are preferably chosen from the E3 series of "*IEC Publication 60063*".

TOLERANCE ON RATED CAPACITANCE

Preferred values of tolerances on rated capacitance

- 20/+ 20 %	- 10/+ 50 %	- 10/+ 30 %	- 10/+ 10 %
M	T	Q	K

These values depend on the relevant series.

VOLTAGE

RATED VOLTAGE (U_R)

The maximum DC voltage, or peak value of pulse voltage which may be applied continuously to a capacitor at any temperature between the lower category temperature and the rated temperature.

CATEGORY VOLTAGE (U_C)

The maximum voltage which may be applied continuously to a capacitor at its upper category temperature.

TEMPERATURE DERATED VOLTAGE

The temperature derated voltage is the maximum voltage that may be applied continuously to a capacitor, for any temperature between the rated temperature and the upper category temperature.

RIPPLE VOLTAGE (U_{RPL})

An alternating voltage may be applied, provided that the peak voltage resulting from the alternating voltage, when superimposed on the DC voltage, does not exceed the value of rated DC voltage or fall under 0 V and that the ripple current is not exceeded.

REVERSE VOLTAGE (U_{REV})

The maximum voltage applied in the reverse polarity direction to the capacitor terminations.

SURGE VOLTAGE (U_S)

The maximum instantaneous voltage which may be applied to the terminations of the capacitor for a specified time at any temperature within the category temperature range.

TEMPERATURE

CATEGORY TEMPERATURE RANGE

The range of ambient temperatures for which the capacitor has been designed to operate continuously: this is defined by the temperature limits of the appropriate category.

RATED TEMPERATURE

The maximum ambient temperature at which the rated voltage may be continuously applied.

MINIMUM STORAGE TEMPERATURE

The minimum permissible ambient temperature which the capacitor shall withstand in the non-operating condition, without damage.

RESISTANCE/REACTANCE

EQUIVALENT SERIES RESISTANCE (ESR)

The ESR of an equivalent circuit having capacitance, inductance and resistance in series measured with alternating current of approximately sinusoidal waveform at a specified frequency; refer to Fig.10.

EQUIVALENT SERIES INDUCTANCE (ESL)

The ESL of an equivalent circuit having capacitance, resistance and inductance in series measured with alternating current of approximately sinusoidal waveform at a specified frequency; refer to Fig.10.

DISSIPATION FACTOR (TANGENT OF LOSS ANGLE; tan δ)

The power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency. The dissipation factor can be approximated by following formula:

$$\tan \delta = ESR \times 2 \pi f C$$

IMPEDANCE (Z)

The impedance (Z) of an aluminum capacitor is given by capacitance, ESR and ESL in accordance with the following equation (see Fig.12):

$$Z = \sqrt{ESR^2 + \left(2 \pi f ESL - \frac{1}{2 \pi f C}\right)^2}$$

CURRENT

LEAKAGE CURRENT (I_L)

The DC current flowing through a capacitor when a DC voltage is applied in correct polarity. It is dependent on voltage, temperature and time.

LEAKAGE CURRENT FOR ACCEPTANCE TEST (I_{L5})

In accordance with international standards ("*IEC 60384-4*" and "*EN130300*") the leakage current (I_{L5}) **after 5 minutes** application of rated voltage at 20 °C is considered as an acceptance requirement.

The leakage current requirements for the majority of Vishay BCcomponents aluminum capacitors, are lower than specified in "*IEC 60384-4*" or "*EN130300*".

If, for example, after prolonged storage and/or storage at excessive temperature (> 40 °C), the leakage current at the first measurement does not meet the requirements, pre-conditioning shall be carried out in accordance with "*EN130300 subclause 4.1*".

LEAKAGE CURRENT AT DELIVERY (I_{L1} OR I_{L2})

In addition to I_{L5}, the leakage current **after 1 minute** application of rated voltage (I_{L1}) is specified in most of the detail specifications.

For some series this value is specified **after 2 minutes** (I_{L2}).

OPERATIONAL LEAKAGE CURRENT (I_{OP})

After continuous operation (1 hour or longer) the leakage current will normally decrease to less than 20 % of the 5 minute value (I_{L5}).

The operational leakage current depends on applied voltage and ambient temperature; see Tables 1 and 2.

LEAKAGE CURRENT AFTER STORAGE WITH NO VOLTAGE APPLIED (SHELF LIFE)

If non-solid aluminum capacitors are stored above room temperature for long periods of time, the oxide layer may react with the electrolyte, causing increased leakage current when switched on for the first time after storage.

Table 1

TYPICAL MULTIPLIER OF OPERATIONAL LEAKAGE CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE										
SYMBOL	MULTIPLIER (1)									
T_{amb} (°C)	- 55	- 40	- 25	0	20	45	65	85	105	125
I_{OP}/I_L	< 0.5	0.5	0.6	0.8	1	1.5	2.5	4	7	10

Note

(1) As far as allowed for the corresponding series

Table 2

TYPICAL MULTIPLIER OF OPERATIONAL LEAKAGE CURRENT AS A FUNCTION OF APPLIED VOLTAGE									
SYMBOL	MULTIPLIER								
U/U_R	< 0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
I_{OP}/I_L	0.1	0.15	0.2	0.3	0.4	0.5	0.65	0.8	1

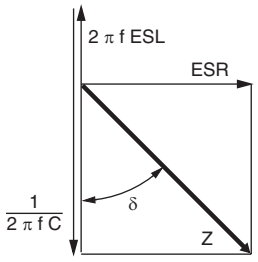


Fig.12 Vector diagram showing the AC parameters of a capacitor

RATED RIPPLE CURRENT (I_R)

Any pulsating voltage (or ripple voltage superimposed on DC bias) across a capacitor results in an alternating current through the capacitor.

Because of ohmic and dielectric losses in the capacitor, this alternating current produces an increase of temperature in the capacitor cell.

The heat generation depends on frequency and waveform of the alternating current.

The maximum RMS value of this alternating current, which is permitted to pass through the capacitor during its entire specified useful life (at defined frequency and defined ambient temperature), is called **rated ripple current** (I_R).

The rated ripple current is specified in the relevant detail specifications at 100 Hz or 120 Hz (in special cases at 100 kHz and at upper category temperature.

Usually the rated ripple current will cause a temperature increase of the capacitor's surface of approximately 3 K or 5 K (dependent on series) compared with ambient temperature. A further temperature increase of 3 K or 5 K will be found in the core of the capacitor.

This temperature rise is the result of the balance between heat generated by electric losses:

$$P = I_R^2 \, ESR$$

and the heat carried off by radiation, convection and conduction:

$$P = \Delta T \times A \times \beta$$

I_R can be determined by the equation:

$$I_R = \sqrt{\frac{\Delta T \times A \times \beta}{ESR}}$$

where:

ΔT = difference of temperature between ambient and case surface (3 K to 5 K, dependent on series)

A = geometric surface area of the capacitor

β = specific heat conductivity, dependent on the size of the capacitor.

The heat, generated by ripple current, is an important factor of influence for non-solid aluminum capacitors for calculating the useful life under certain circumstances.

In the detail specifications this factor is considered in the so-called 'life-time nomograms' ('Multiplier of useful life' graph) as a ratio between actual ripple current (I_A) and rated ripple current (I_R), drawn on the vertical axis.

Care should be taken to ensure that the actual ripple current remains inside the graph at any time of the entire useful life. If this cannot be realized, it is more appropriate to choose a capacitor with a higher rated voltage or higher capacitance, than originally required by the application.

The internal losses and the resultant ripple current capability of aluminum capacitors are frequency dependent. Therefore, a relevant frequency conversion table ('Multiplier of ripple current as a function of frequency') is stated in the detail specifications. See also "CALCULATION OF USEFUL LIFE BY MEANS OF 'LIFE-TIME NOMOGRAMS'."

CALCULATION OF THE APPLICABLE RMS RIPPLE CURRENT

Non-sinusoidal ripple currents (if not accessible by direct measurement) have to be analysed into a number of sinusoidal ripple currents by means of Fourier-analysis; the vectorial sum of the currents thus found may not exceed the applicable ripple current.

For some frequently occurring waveforms, approximation formulae are stated in Fig.13 for calculating the corresponding RMS value.

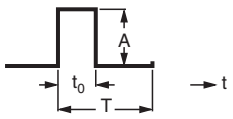
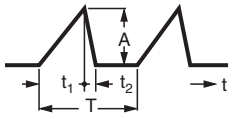
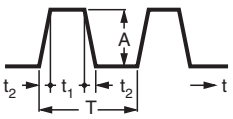
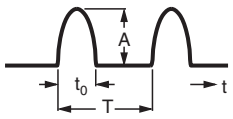
WAVE FORM	RMS VALUE
	$A\sqrt{\frac{t_0}{T}}$
	$A\sqrt{\frac{t_1 + t_2}{3T}}$
	$A\sqrt{\frac{2\,t_1 + 3\,t_2}{3T}}$
	$A\sqrt{\frac{t_0}{2T}}$

Fig.13 Approximation formulae for RMS values of non-sinusoidal ripple currents

STORAGE

No pre-condition will be necessary for Vishay BCcomponents aluminum capacitors, when stored under standard atmospheric conditions (15 °C to 25 °C; 25 % to 75 % RH; 860 mbar to 1060 mbar) for the following periods of time:

3 years for non-solid 85 °C types

4 years for non-solid 105 °C types

10 years for non-solid 125 °C types

20 years for solid types.

After these periods, the leakage current for acceptance test shall not exceed twice the specified I_{L5} requirement.

A limited current can be applied to reduce the leakage current of long stored capacitors to normal values. The maximum allowed current when doing this at room temperature is given by the following formula:

$$I_{max.} = \frac{\beta \times \pi}{U_r} \times \left(\left(\frac{D}{2}\right)^2 + D \times L\right)$$

In this equation, U_r is the rated voltage, D the diameter of the capacitor can and L the length of the capacitor can. When $I_{max.}$ is in mA, D in mm and L in mm, the value for β is 1 mW/mm^2. During this reforming process, the rated voltage shall not be exceeded.The process has ended when the current drops below the specified leakage current.

To ensure good solderability and quality of taping, for all types and prior to mounting, the storage time shall not exceed 3 years. This means for example: 2 years storage time between manufacture and arrival at the customer, plus 1 year in customer storage.

OPERATIONAL CONDITIONS

CHARGE-DISCHARGE PROOF

This term means the capability of capacitors to withstand frequent switching operations without significant change of capacitance.

Vishay BCcomponents aluminum capacitors are charge-discharge proof in accordance with "*IEC 60384-4*" and "*EN130300 subclause 4.20*": unless otherwise specified, 10^6 switching operations (RC = 0.1 s) shall not cause a capacitance change of more than 10 %.

Non-frequent charging and discharging, without a series resistor, will not damage the capacitor.

If a capacitor is charged and discharged continuously several times per minute, the charge and discharge currents have to be considered as ripple currents flowing through the capacitor. The RMS value of these currents should be determined and the resultant value must not exceed the applicable limit.

ENDURANCE TEST

In "*IEC 60384-4*" or "*EN130300*" the criteria for the acceptable drift of electrical parameters after the endurance test at U_R and upper category temperature are defined.

Test duration and conditions per series are stated in the relevant detail specification.

The endurance test does not provide information about the useful life of a capacitor, as no failure percentage is defined for this test.

USEFUL LIFE

Useful life (other names: load life, life time or typical life time) is that period of time, during which a given failure percentage may occur, under well defined conditions and requirements. Useful life data are usually calculated with a confidence level of 60 %.

High quality of materials and controlled manufacturing processes provided, the useful life of non-solid aluminum capacitors is, in most cases, determined by evaporation of electrolyte through the sealing.

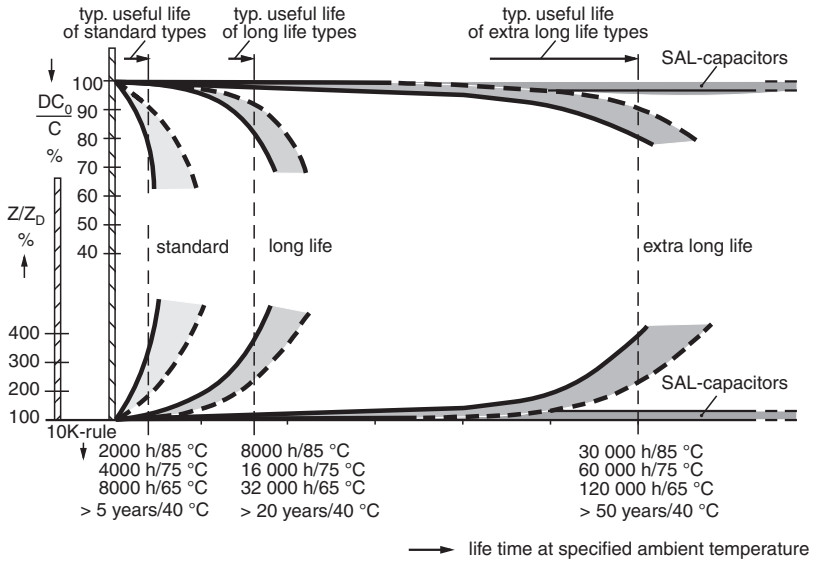
Figure 14 shows the principal electrical consequences of this electrolyte loss: increasing impedance and decreasing capacitance at the end of useful life, for different non-solid types.

Due to the fact that no liquid electrolyte is used in solid aluminum capacitors, the associated failure mechanism does not occur.

For non-solid aluminum capacitors the influence of temperature on useful life is approximated by the so-called '10 K-rule'. The '10 K-rule' states that double the life time can be expected per 10 K temperature decrease; this principle is derived from the well known law of Arrhenius about acceleration of reaction processes.

The exact temperature dependence of useful life for a particular range is given in the corresponding detail specification in the 'life-time nomogram' ('Multiplier of useful life' graph in the detail specifications). Detailed performance requirements, on which the definition 'useful life' is based, are also stated in the relevant detail specifications.

Exceeding those requirements shall not necessarily induce a malfunction of the equipment involved. The performance requirements offer advice on the choice of components and design of the circuitry.



C_0 = initial value of capacitance

Z_D = specified limit of impedance

Fig.14 Principal trend of electrical parameters during useful life of different aluminum capacitors

CALCULATION OF USEFUL LIFE BY MEANS OF 'LIFE-TIME NOMOGRAMS'

Based on the Arrhenius law and on experience for some decades, a nomogram is specified in the detail specification for each range, where the influence of ambient temperature and ripple current on the expected useful life is shown. Ripple currents at other frequencies than specified must be corrected using the frequency conversion tables in the relevant detail specification.

The ratio of actual ripple current to rated ripple current (I_A/I_R) is plotted on the vertical axis and the ambient temperature (T_{amb}) on the horizontal.

At the intersection of these two operational conditions the appropriate multiplier (correction factor) for useful life can be read. The useful life under certain conditions shall be calculated by multiplying (or dividing respectively) the specified useful life, with the resultant correction factor.

The useful life determined by this procedure is normally valid for applications without forced cooling. Under certain conditions and with additional cooling, the useful life may be considerably extended.

Axial and radial 85 °C types

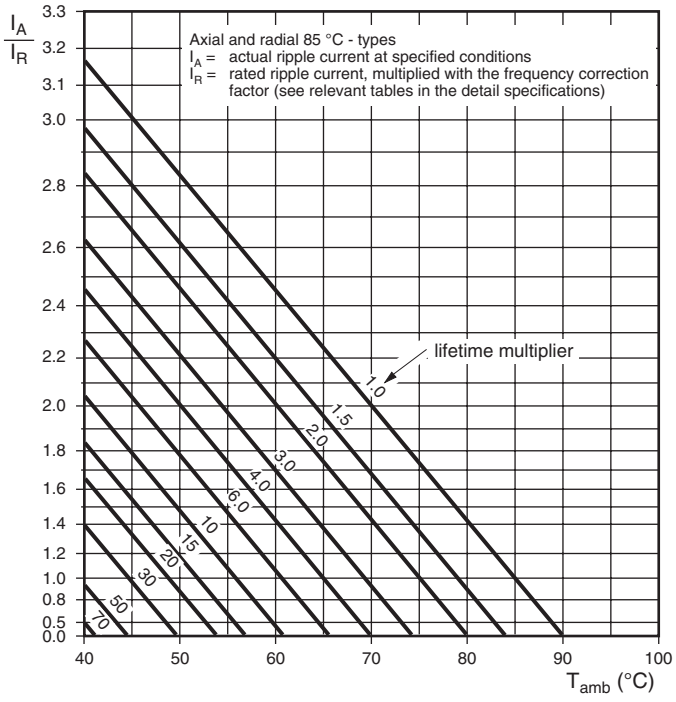


Fig.15 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load

Axial and radial 105 °C types

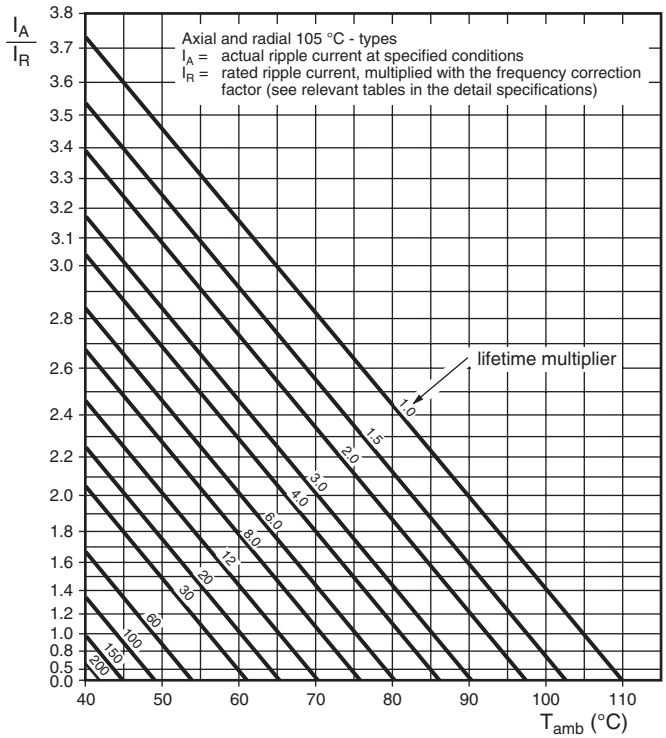


Fig.16 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current

EXAMPLES FOR THE USE OF 'LIFE-TIME NOMOGRAMS'

Example 1

Temperature in (operating) equipment is 45 °C.

Ripple current load is exactly the rated value (thus: $I_A/I_R = 1$).

Which useful life can be expected (without pause and storage times):

1. for a capacitor with a specified useful life of 2000 hours at 85 °C
2. for a capacitor with a specified useful life of 2000 hours at 105 °C

Solution:

The corresponding life-time multiplier may be found at the intersection between the vertical '45 °C-line and the horizontal '1'-line. For the 85 °C type this is '30' (see Fig.15) and for the 105 °C type it is '90' (see Fig.16).

Resulting useful life is thus:

1. for 85 °C type: 30 x 2000 hours = 60 000 hours or about 7 years
2. for 105 °C type: 90 x 2000 hours = 180 000 hours or about 20 years.

Example 2

Which life time requirement has to be fulfilled by the capacitors, if the equipment life shall be 10 years (approx. 100 000 hours), consisting of 1000 hours at 75 °C + 9000 hours at 65 °C + 90 000 hours at 40 °C
No ripple current applied (thus: $I_A/I_R = 0$).

Solution:

The mentioned life-times shall be converted to specified 85 °C or 105 °C life-times, i.e. they have to be divided through the correction factors found at the intersection of the respective operational conditions (see Table 4).

The required life-time can be fulfilled by types with a specified useful life of:

1. > 2970 hours at 85 °C i.e. a 3000 hours/85 °C type, or
2. > 935 hours at 105 °C i.e. a 1000 hours/105 °C type.

Example 3

Which internal temperature may occur in the equipment, if the actual ripple current at 10 kHz is 3 times higher than specified for a 16 V-type and the load limit may not be exceeded?

Solution:

The ripple current must first be converted from 10 kHz to 100 Hz by using the conversion table (see typical example, Table 3). This shows that the conversion factor for a 16 V-type is 1.2.

$I_A/I_R = 3$ at 10 kHz and must be divided by 1.2, resulting in $I_A/I_R = 2.5$ at 100 Hz.

The load limit is defined by the diagonal line 'multiplier 1' in the relevant nomogram.

This means here: the vertical line on the intersection of $I_A/I_R = 2.5$ and the multiplier 1-line shows the maximum permitted internal temperature:

1. for 85 °C types this is max. 59 °C
2. for 105 °C types this is max. 79 °C

The corresponding life-time in this case is equal to the specified useful life.

Table 3

TYPICAL EXAMPLE OF A FREQUENCY CONVERSION TABLE (1)			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥ 10 000	1.20	1.40	1.60

Note

(1) ($I_{R, f}/I_R$) as a function of frequency; I_R = rated ripple current at 100 Hz

Table 4

LIFE-TIME CALCULATION in "example 2"		
LIFE CONDITIONS	**85 °C TYPES** (see Fig.15)	**105 °C TYPES** (see Fig.16)
1000 hours at 75 °C	1000/2.9 = 345 h	1000/8 = 125 h
9000 hours at 65 °C	9000/6 = 1500 h	9000/20 = 450 h
90 000 hours at 40 °C	90 000/80 = 1125 h	90 000/250 = 360 h
	sum for 85 °C = **2970** h	sum for 105 °C = **935** h

FAILURE RATE (λ) TOTAL FAILURE PERCENTAGE

Aluminum capacitors, like many other electronic components and devices, exhibit a failure rate which varies with time as depicted in the familiar 'bathtub' curve (see Fig.17). Three distinct regions can be discerned:

(a) Burn-in period, showing a rapidly decreasing failure rate. During production of Vishay BCcomponents' aluminum capacitors all capacitors undergo a re-forming process which is a short burn-in. All capacitors shipped have passed burn-in.

(b) Constant failure period, showing a low failure rate for a long period. This is the 'useful life' period of the aluminum capacitor. The detail specifications of the relevant series specify the upper limit for the total failure percentage (TFP) during this period. For non-solid aluminum capacitors this limit is usually not reached before the wear-out period begins.

(c) Wear-out period, showing an increasing failure rate due to gradual deterioration. For aluminum capacitors with non-solid electrolyte, the onset of this period can be calculated with the nomogram (see Fig.18).

The failure rate is the number of components failing within a unit of time. For region (b), where the failure rate has a constant value λ, the total failure percentage as a function of time, TFP(t), can be expressed as:

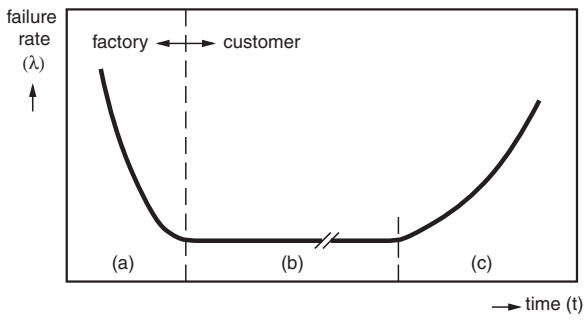
$$TFP(t) = \left\{1 - \frac{N(t)}{N(0)}\right\} \times 100\ \% = (1 - e^{-\lambda \times t}) \times 100\ \%$$

with

$$\lambda = (\lambda_{40\ °C,\ 0.5\ U_R} \times mult)(T, U/U_R)$$

N(t) is the number of components that have not failed after time t. As λ mainly depends on two stress factors, temperature and the ratio of applied voltage to rated voltage, it is common to normalise it to reference conditions, T_{amb} = 40 °C and U = 0.5 x U_R. The value for $\lambda_{40\ °C,\ 0.5\ U_R}$ is calculated from results of periodical tests in the quality laboratories or derived from field observations.

In order to calculate λ for other operating conditions, the value for the failure rate multiplying factor, mult (T, U/U_R) in the formula above, must be taken from Fig.18 (non-solid aluminum capacitors) or Fig.19 (solid aluminum capacitors).



a) Initial failure priod ('infant mortality')
b) Random failure period (= useful life period)
c) Wear-out failure period

Fig.17 Failure rate (λ) as a function of time ('bathtub' curve)

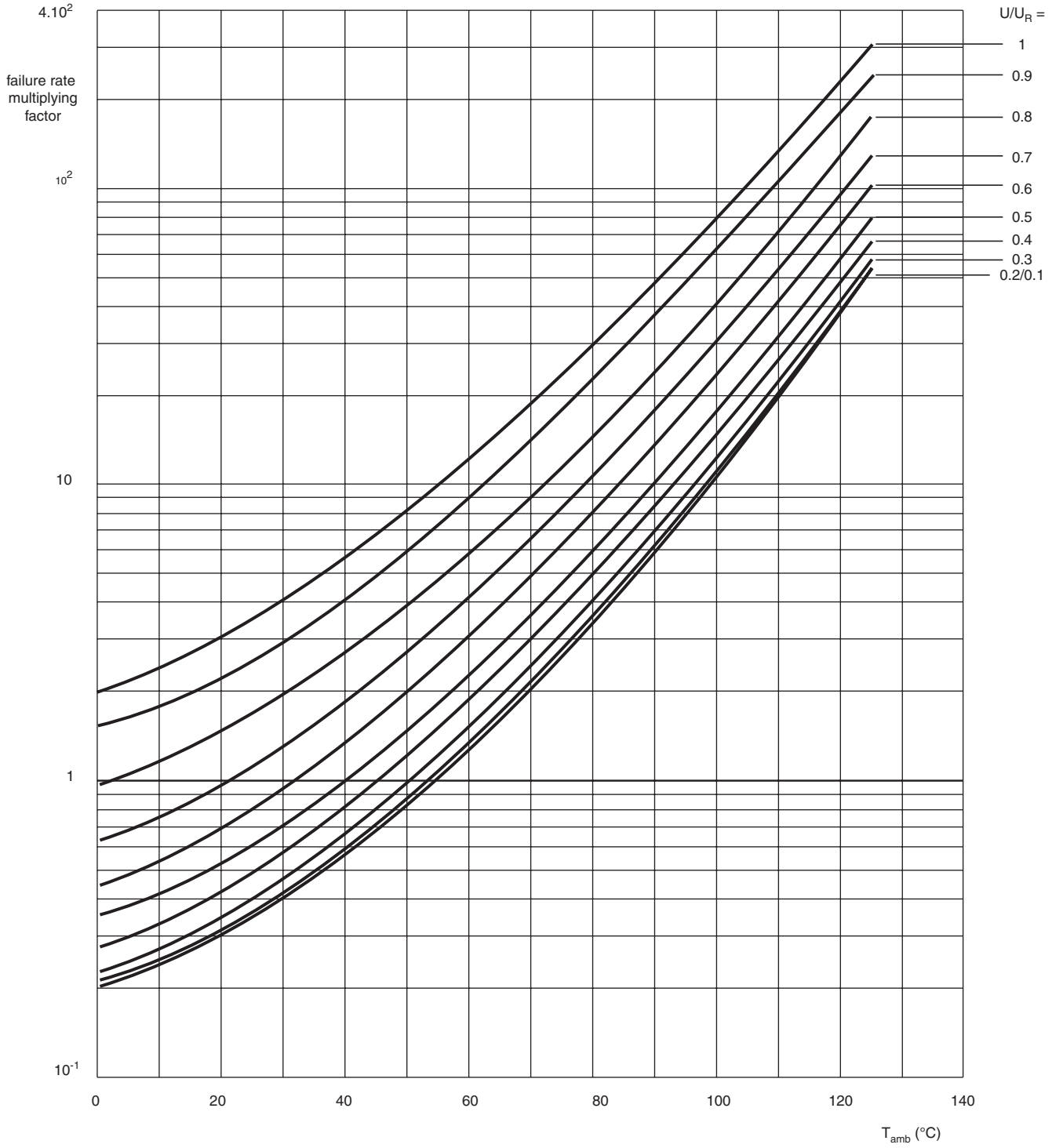


Fig.18 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for non-solid aluminum capacitors

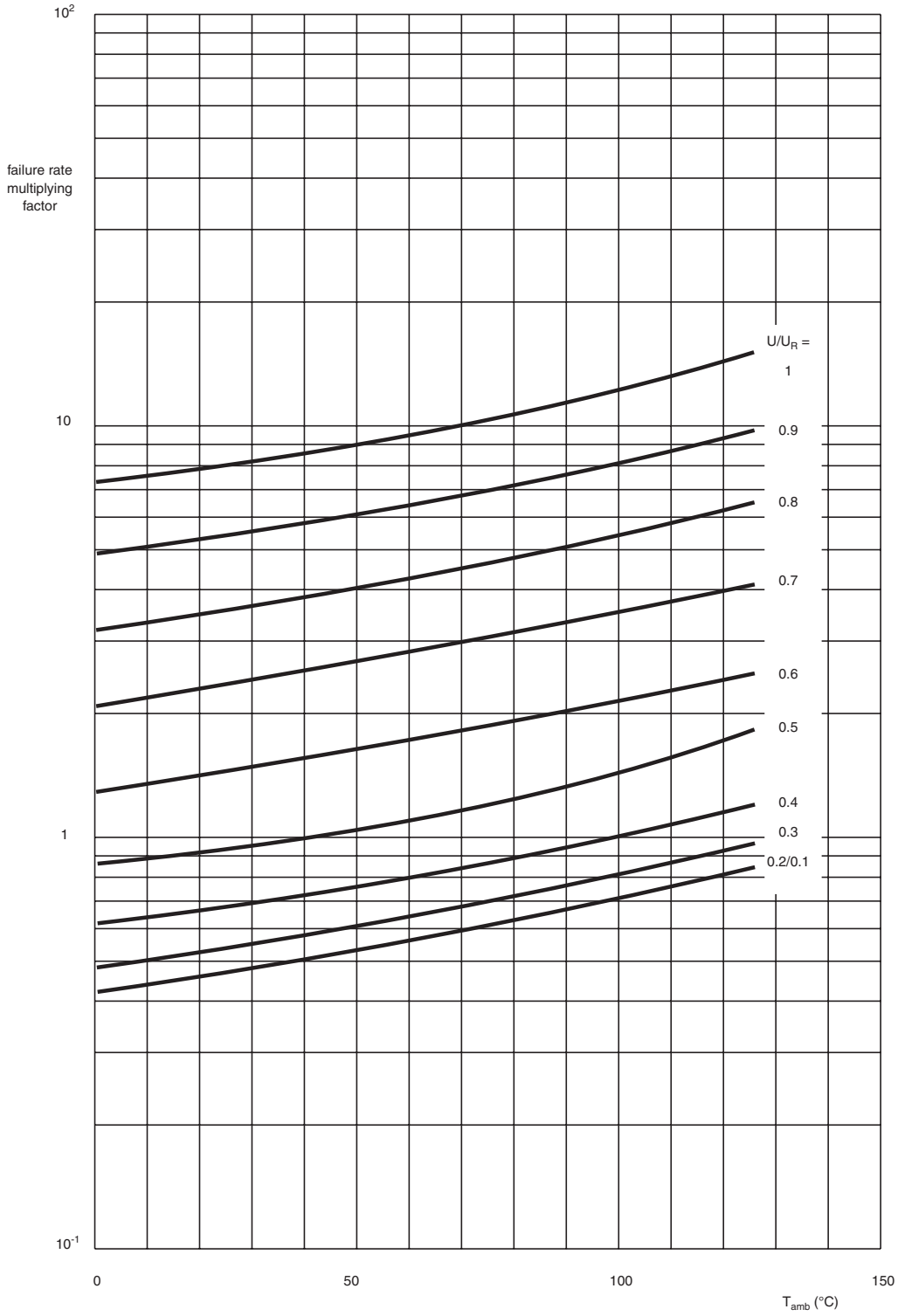


Fig.19 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for solid aluminum capacitors

CLIMATIC CATEGORY

For each capacitor range the climatic category in accordance with "*IEC 60068-1*" is stated in the relevant detail specification. The climatic category consists of three digit groups; example given in Table 5.

Table 5

EXAMPLE OF CLIMATIC CATEGORIES				
Example:	40	085	56	
	40			lower category temperature (here: - 40 °C)
		085		upper category temperature (here: + 85 °C)
			56	duration of test 'damp heat, steady state' (here: 56 days)

Table 6

MAXIMUM HUMIDITY CONDITION INDICATION FOR THE APPLICATION CLASS				
CODE LETTER	RELATIVE AIR HUMIDITY			
	YEARLY AVERAGE	30 DAYS PER YEAR	OCCASIONALLY	DEWING
C	≤ 95 %	100 %	100 %	permitted
D	≤ 80 %	100 %	90 %	permitted
E	≤ 75 %	95 %	85 %	slightly/rarely
F	≤ 75 %	95 %	85 %	not permitted

APPLICATION CLASS

Although the German standard "*DIN 40040*" has been withdrawn, it is still widely used in industrial specifications for the definition of climatic working conditions. The application class consists of 3 code letters which have the following meanings.

CODE LETTER MEANINGS

1st letter:	lower category temperature F: - 55 °C; G: - 40 °C; H: - 25 °C
2nd letter:	upper category temperature P: + 85 °C; M: + 100 (+ 105) °C; K: + 125 °C
3rd letter:	maximum humidity conditions (see Table 6)

MOUNTING

MOUNTING POSITION OF NON-SOLID ALUMINUM CAPACITORS

Snap-in and printed wiring (PW) as well as solder lug (SL) aluminum capacitors, in addition to the larger case sizes of axial and radial types, are normally equipped with pressure relief in the aluminum case. These and all smaller case size types, may be mounted in any position.

Screw-terminal aluminum capacitors have a pressure relief in the sealing disc. These types shall be mounted so that no emissions of electrolyte or vapour may reach either the conductors under voltage, or other parts of the printed circuit board. Vertical (pressure relief up) or horizontal (pressure relief on the upper side) mounting position is recommended.

DESIGN RULES FOR 'CAPACITOR BATTERIES'

MECHANICAL

Vishay BCcomponents large aluminum capacitors are mainly used in power supply applications under high ripple current load. In these circumstances, the capacitors must be mounted with a distance of ≥ 15 mm from each other, in order to allow sufficient air circulation and to prevent mutual radiation.

Likewise, if axial or radial types are subject to high ripple load, they shall be mounted with sufficient distance (e.g. ≥ 10 mm) from each other for good convection.

ELECTRICAL

Parallel connection

Aluminum capacitors may be connected in parallel, but for safety reasons, large sizes should be individually guarded against sudden energy discharge of the whole battery due to a defective specimen.

Series connection

If two aluminum capacitors are connected in series, balancing resistors are required; see Fig. 20. Without these resistors, leakage current through both capacitors is the same. Because the leakage current for two capacitors can be quite different when the same voltage is applied, forcing the same current through both capacitors will mean that the voltage will not divide evenly. One capacitor might be subjected to a voltage exceeding its rated voltage. Parallel balancing resistors limit the difference in voltage across the capacitors under DC conditions.

For practical purposes the following equation can be used to calculate the maximum possible resistor

values in ohms: $R = \frac{2 \times U_m - U_{total}}{I_{L5}}$

Here, U_m is the maximum (rated) voltage that may be present on one of the capacitors and I_{L5} is the specified leakage current in amperes after 5 minutes (used as an approximation of the difference in leakage current between C1 and C2).

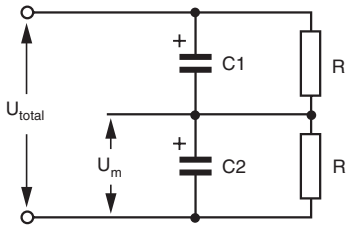


Fig.20 Balancing resistors for two aluminum capacitors in series

Combined series/parallel connection

The above mentioned rules for both series and parallel connection are accordingly valid for any combination of these two cases.

MARKING

Vishay BCcomponents aluminum capacitors are identified in accordance with "*IEC*" rules. When sufficient space is available, capacitors are marked with the following details:

Rated capacitance	in µF (the 'µ' sign represents the position of the decimal point)
Rated voltage	in V
Tolerance on rated capacitance	if necessary, as a letter code in accordance with "*IEC 60062*", e.g. T for - 10/+ 50 % M for ± 20 % K for ± 10 % Q for - 10/+ 30 % A for tolerance according to detail specification
Group number	3-digit part of the catalog number, e.g. 036 for RSP series
Catalog number	or last 8-digits of the catalog number
Name of manufacturer	BCcomponents or BCC or BC
Date code	abbreviation in 2 digits ("*IEC 60062*"), e.g.

1st digit		2nd digit	
R	= 2003	1	= January
S	= 2004	2	= February
T	= 2005		...
U	= 2006	9	= September
V	= 2007	O	= October
W	= 2008	N	= November
X	= 2009	D	= December
A	= 2010		
B	= 2011		

example:

WO = produced in 2008, October

production date may also be stated as year/week code

Date code may also be stamped in the case.

Factory code	indicating the factory of origin
Polarity identification	strip, band or negative symbol ('-' sign) to indicate the negative terminal and/or a '+' sign to identify the positive terminal.

Aluminum Capacitors

WARNING

Correct application and strict adherence to the important information listed below will ensure optimum performance of the capacitors over their entire specified useful life.

Please note that ignoring these rules may reduce the equipment lifetime or even destroy the capacitor, together with parts of the equipment or property involved. The consequences may be a short or open circuit of the component, leakage of electrolyte or heat generation. Opening of the case or vent (danger of injury) may be regarded as hazardous and cause liquids, vapors or dust to be released. Similar precautions should be taken when testing aluminum capacitors.

Please consult your local Vishay sales organization, if one or more of these limits cannot be adhered to.

GUIDELINES

PARAMETER	IMPORTANT INFORMATION - PRODUCT SAFETY	MORE DETAILS
DESIGN		
VOLTAGE	**Do not apply a voltage exceeding the capacitor's voltage rating.** Check the maximum voltage across the capacitor that may occur over the whole equipment life. In normal operation the rated voltage of the capacitor shall not be exceeded; if so, early failures may occur. However, for short periods the voltage may be raised up to surge voltage value (see Detail Specification); for conditions and maximum parameter changes, see section *"Tests and Requirements"*.	Detail Specification TESTS AND REQUIREMENTS
RIPPLE LOAD	**Do not allow excessive ripple current to pass.** The rated ripple current as calculated for the application conditions (see section "Introduction"), shall not be exceeded. If so, early failure may result. **Keep ripple voltage within ratings.** The sum of DC-bias and maximum amplitude of ripple voltage shall be within rated voltage and 0 V. Aluminum capacitors are not normally designed for AC application.	Detail Specification INTRODUCTION
TEMPERATURE CHANGE	**Use capacitors within specified temperature range.** Applicable temperature range is given in the relevant detail specification. A general principle is that lower ambient temperature means longer life; therefore, wherever possible, aluminum capacitors should be placed at the coolest positions on the board (please ensure that aluminum capacitors are placed away from 'heating' components such as power resistors, switching diodes/transistors or transformers). Exceeding the permitted temperature range may cause early failures.	Detail Specification
CHARGE-DISCHARGE	**Observe charge-discharge limitations.** Frequent charge-discharge load via low resistance may cause capacitance drop or destroy the capacitor. Under well defined conditions (see section *"Tests and Requirements")* frequent charge-discharge operation is allowed. The resulting current through the capacitor must not exceed the ripple current limit. Standard aluminum capacitors are not suitable for flash applications.	TESTS AND REQUIREMENTS
SERIES/ PARALLEL CONNECTIONS	**When connecting in series/parallel, apply corresponding design rules.** Connecting aluminum capacitors in series/parallel is possible, provided that balancing resistors are applied to each capacitor, in order to stabilize the voltage over each individual capacitor. Rules for correct design are given in section "Introduction".	INTRODUCTION
PC BOARD DESIGN	Conducting tracks or lands should not be located under upright mounted aluminum capacitors; short circuits under the capacitor with danger of fire could be the result.	
INSULATION	**The capacitor case is not insulated from the cathode terminal.** Axial capacitors have a direct contact between case and cathode terminal; radial and power capacitors exhibit an indeterminate resistance between the cathode terminal and the metal case. Metal parts other than terminals should never make contact with conducting tracks or metal parts of other components. Dummy pins should be connected to the cathode.	
MOUNTING		
POLARITY, REVERSE VOLTAGE	**Aluminum capacitors for DC applications require polarization.** Check the polarity of each capacitor: both in circuit design and in mounting (polarity is clearly indicated on the capacitor). For short periods a limited reverse voltage is allowed (see Detail Specification); for conditions and maximum parameter changes, see section "*Tests and Requirements"*. Exceeding reverse voltage may result in early failures.	Detail Specification TESTS AND REQUIREMENTS

GUIDELINES		
PARAMETER	**IMPORTANT INFORMATION - PRODUCT SAFETY**	**MORE DETAILS**
PLACEMENT	**Avoid excessive stress to the lead wires or terminals.** Excessive stress can be caused by component processing machines if lead wires are not sufficiently fixed during bending, cutting, cropping or inserting operations. Other possible reasons are incorrect hole distance on the printed circuit or bending of the component after soldering. Care should be taken when the manual bending of terminals or mounted capacitors is required. For maximum allowed mechanical load and time of application, see section *"Tests and Requirements"*. Mechanically damaged capacitors may not be used. Pressure relief should have enough space to function correctly.	TESTS AND REQUIREMENTS
SOLDERING	**Keep soldering temperature and time under control.** For maximum soldering conditions, see section *"Tests and Requirements"*. Additional temperature load e.g. for curing the glue of Surface Mount Devices (SMDs) are allowed to a certain limit, which depends on series and exact details. Please apply to your sales engineer for your specific conditions. Molten solder or the soldering iron should not make contact with the capacitor's insulation. Reflow soldering is only suitable for SMD components.	TESTS AND REQUIREMENTS
BOARD CLEANING	**No guarantees can be given with regard to solvents based on halogenated hydrocarbons or ozone depleting chemicals (ODCs).** **Warning: such solvents are hazardous to the environment.** Component cleaning using solvents such as demineralized or distilled water, isopropanol, methanol, ethanol and propanol would not normally have any detrimental effects and therefore do not require any special precautions. Aqueous cleaning methods may be used in conjunction with saponification using a neutral detergent like calgonite at 20 g/l. It is recommended that immediate drying of the component in hot air is carried out at approximately 85 °C (or 70 °C for products with an upper category temperature of 70 °C) for at least 5 minutes. For further information regarding the application of solvent temperatures exceeding the temperature mentioned in *"IEC 60068-2-45"*, consult your local Vishay sales organization.	
ADHESIVES, COATING MATERIALS	**Some adhesives and coating materials affect capacitors adversely.** For varnishing, coating, lacquering, embedding or gluing at the capacitor's sealing, ensure that the materials used are halogene-free in all their constituent parts (base material, thinners, binders, reacting agents, propellants, additives). For reasons see 'BOARD CLEANING' above. When applying such materials, ensure that the rubber area is not completely sealed off.	
STORAGE AND TRANSPORT		
STORAGE CONDITIONS, HANDLING	**Excessive storage time or conditions may have adverse effects on capacitors.** Capacitors should be stored at room temperature, low humidity and out of direct sunlight. Storage at elevated temperature and/or high relative humidity may have a negative influence on taping accuracy, solderability, leakage current and life expectancy. Packages with aluminum capacitors should be handled with care, otherwise bent leads and/or incorrect taping dimensions could be the result.	INTRODUCTION TESTS AND REQUIREMENTS
HIGH AIR PRESSURE	**Do not expose capacitors to overpressure.** Maximum operating pressure is 150 kPa. Higher pressure may cause a short circuit.	
LOW AIR PRESSURE	**The capacitors may be used up to an altitude of ≤ 12 000 m.** Minimum air pressure: 8.5 kPa for short periods (in accordance with *"IEC 60384-4, sub clause 4.11.4"*).	TESTS AND REQUIREMENTS
DISINFECTING E.G. FOR SARS	**No guarantees can be given when disinfectants are/have been used.** Disinfectants may contain halogens like chlorine, fluorine, bromine etc. and alkaline solutions. Disinfectants should not be used near or on the capacitor. Over time they can cause corrosive reactions to capacitors resulting in reduced capacitance, open circuits etc. For further information please consult your local Vishay sales organization	
EMERGENCY		
PERSONNEL SAFETY	**WARNING NOTE.** Non-solid aluminum capacitors may contain chemicals which can be regarded as hazardous if handled incorrectly. Caution is necessary if the outer case is fractured; vapors or dust particles should not be inhaled (good ventilation is essential); skin, eye or clothing contact with liquids should be avoided. In case of such contact, flush thoroughly with running water as soon as possible, then wash skin or clothing with soap and water or a mild detergent. Any possible discoloration of the wetted skin will disappear after a few days. In the event of fire, the organic parts of aluminum capacitors may release such constituents as carbon monoxide, nitric oxides or dust particles; take caution when breathing-in.	
END OF LIFE		
DISPOSAL	**Aluminum capacitors are subject to special waste regulations.** Aluminum capacitors are free from PCB- or PBDE-containing substances. Dioxines or furanes are not constituent parts of aluminum capacitors. However, because of other polluting ingredients, larger quantities (in weight) of aluminum capacitors are subject to special waste regulations in accordance with the relevant national laws; please consult your local Vishay sales organization. In general, disposal of aluminum capacitors must take place under controlled circumstances in a high temperature incinerator at minimum 900 °C.	

Aluminum Capacitors

TESTS AND REQUIREMENTS

This datasheet contains an abridged version of tests and requirements given in *"IEC 60384-4"* or *"EN130300"* respectively. Correct sequence of measurement for electrical parameters in accordance with *"IEC 60384-4"*:

1. Leakage current
2. Capacitance
3. tan δ or ESR
4. Impedance

Table 1

NON-SOLID ALUMINUM TYPES				
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**IEC 60068-2 TEST METHOD**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Robustness of terminations:	4.4			
Tensile strength		Ua	leaded types: loading force 10 N for 10 s power types: loading force 20 N for 10 s	no visible damage
Bending		Ub	leaded types: loading force 5 N two consecutive bends	no visible damage
Torsion		Uc	leaded types, axial: two successive rotations of 180° in opposite direction; 5 s per rotation	no visible damage
Torque on nut (stud)		Ud	power types/screw terminal: torque of 176 Nm gradually applied	no visible damage
Resistance to soldering heat	4.5	Tb (method 1A)	solder bath: 260 °C; 10 s	no visible damage; marking legible $\Delta C/C$: ± 5 %
Solderability	4.6	Ta	solder bath: 235 °C; 2 s; immersed up to 2 mm from the body; non activated flux	no visible damage; marking legible ≥ 95 % tinning
Rapid change of temperature	4.7	Na	for Snap-In, DIN-PW and Screw Terminal capacitors: 5 cycles of 3 h at lower and upper category temperature for axial, radial and SMD capacitors: 5 cycles of 30 min at lower and upper category temperature	no visible damage; no leakage of electrolyte
Vibration (1)	4.8	Fc	10 Hz to 500 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 h per direction form MR or ST types: 10 Hz to 55 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 h per direction	no visible damage; no leakage of electrolyte; marking legible $\Delta C/C$: ± 5 % with respect to initial measurements
Bump (1)	4.9	Eb	40 g; 2 directions; 4000 bumps total form MR: 40 g; 2 directions; 1000 bumps total	no visible damage; no leakage of electrolyte $\Delta C/C$: ± 5 % with respect to initial measurement
Climatic sequence:	4.11			
Dry heat	4.11.1	Ba	16 h at upper category temperature; no voltage applied	no visible damage; no leakage of electrolyte
Damp heat, cyclic	4.11.2	Db	1 cycle (55 °C → 25 °C) of 24 h; RH 95 % to 100 %; no voltage applied	
Cold	4.11.3	Aa	2 h at lower category temperature; no voltage applied	no visible damage; no leakage of electrolyte

NON-SOLID ALUMINUM TYPES				
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**IEC 60068-2 TEST METHOD**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Low air pressure	4.11.4	M	5 min at 25 °C ± 10 °C; at atmospheric pressure of 8.5 kPa; U_R applied during last min	no visible damage; no evidence of breakdown or flashover
Damp heat, cyclic	4.11.5	Db	5 cycles (55 °C → 25 °C) of 24 h each; RH 95 % to 100 %; no voltage applied	
Sealing	4.11.6	Qc	1 min in water at 90 °C	no continuous chain of bubbles
	4.11.7		final measurement after climatic sequence	no visible damage; no leakage of electrolyte; marking legible leakage current ≤ stated limit tan δ ≤ 1.2 x stated limit ΔC/C: ± 10 %
Insulation resistance	4.3.5		insulation sleeve: foil method	insulation resistance ≥ 100 MΩ
Voltage proof	4.3.6		insulation sleeve: foil method; 1000 V for 1 min	no breakdown or flashover
Damp heat, steady state	4.12	Ca	56 d at 40 °C; RH 90 % to 95 %; no voltage applied	no visible damage; no leakage of electrolyte; marking legible leakage current ≤ stated limit tan δ ≤ 1.2 x stated limit insulation resistance > 100 MΩ; no breakdown or flashover below 1000 V ΔC/C: ± 10 %
Endurance	4.13		for test duration, refer to the relevant datasheet in this data book; at upper category temperature; U_R applied	no visible damage; no leakage of electrolyte; marking legible leakage current ≤ stated limit insulation resistance > 100 MΩ; no breakdown or flashover below 1000 V U_R ≤ 6.3 V; ΔC/C: + 15 %/- 30 %; 6.3 V < U_R < 200 V; ΔC/C: ± 15 %; U_R ≥ 200 V; ΔC/C: ± 10 % tan δ ≤ 1.3 x stated limit impedance ≤ 2 x stated limit
Surge	4.14		from source of 1.15 x U_R for U_R ≤ 315 V or 1.1 x U_R for U_R > 315 V RC = 0.1 s ± 0.05 s 1000 cycles of 30 s on, 330 s off, at upper category temperature	no visible damage; no leakage of electrolyte leakage current ≤ stated limit tan δ ≤ stated limit ΔC/C: ± 15 %

NON-SOLID ALUMINUM TYPES				
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**IEC 60068-2 TEST METHOD**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Reverse voltage	4.15		1 V in reverse polarity followed by U_R in forward polarity, both for 125 h at upper category temperature	leakage current ≤ stated limit tan δ ≤ stated limit ΔC/C: ± 10 %
Pressure relief (only for types with vent)	4.16		DC voltage applied in reverse direction producing a current of 1 A to 10 A	pressure relief opens prior to danger of explosion or fire
Storage at upper category temperature	4.17	Ba	test duration 500 h at upper category temperature; for longer test duration (shelf life), refer to the relevant datasheet in this data book	no visible damage; no leakage of electrolyte leakage current ≤ 2 x stated limit tan δ ≤ 1.2 x stated limit ΔC/C: ± 10 %
Storage at low temperature	4.18	Ab	72 h at the lower category temperature	no visible damage; no leakage of electrolyte leakage current ≤ stated limit tan δ ≤ stated limit ΔC/C: ± 10 %
Characteristics at high and low temperatures	4.19		step 1: reference measurement of impedance at 20 °C and 100 Hz	
		Aa	step 2: measurement at lower category temperature	impedance at 100 Hz: ≤ 7 x value of step 1 for U_R ≤ 6.3 V or U_R > 160 V; ≤ 5 x value of step 1 for 6.3 V < U_R ≤ 16 V; ≤ 4 x value of step 1 for 16 V U_R 160 V
		Ba	step 3: measurement at upper category temperature	leakage current: ≤ 10 x stated limit at 125 °C; ≤ 8 x stated limit at 105 °C; ≤ 5 x stated limit at 85 °C; ≤ 3 x stated limit at 70 °C
Charge and discharge	4.20		for U_R ≤ 160 V: 10^6 cycles of 0.5 s charge to U_R (RC = 0.1 s) and 0.5 s discharge (RC = 0.1 s); for U_R > 160 V: under consideration	no visible damage; no leakage of electrolyte ΔC/C: ± 10 %
Additional tests in accordance with IEC 60384-1 and EN 130000				
Solvent resistance	4.31	Xa	immersion: 5 min ± 0.5 min with or without ultrasonic at 55 °C ± 0.5 °C solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
Passive flammability	4.38	IEC 60695-2-2	needle flame test	category of flammability: B

Notes

For vibration and bump testing, the components shall be mounted by their terminations (with mounting accessories where applicable).
The following capacitors shall also be clamped by their body:

a) Radial types: Ø D_{nom} ≥ 12.5 mm; L_{nom} ≥ 15 mm

b) Axial types: Ø D_{nom} ≥ 12.5 mm; L_{nom} ≥ 30 mm

Table 2

SOLID ALUMINUM TYPES, SAL				
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**IEC 60068-2 TEST METHOD**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Robustness of terminations:	4.4			
Tensile strength (1)		Ua	loading force; 10 N for 10 s	no visible damage
Bending (1)		Ub	loading force; 5 N; two consecutive bends	no visible damage
Torsion (axial types)		Uc	two successive rotations of 180° in opposite direction; 5 s duration per rotation	no visible damage
Resistance to soldering heat	4.5	Tb (method 1A)	radial types: solder bath: 260 °C; 10 s	no visible damage; markings legible $\Delta C/C$: ± 5 % with respect to initial measurement
		Tb (method 1B)	axial types: solder bath 350 °C for 3.5 s	
Solderability	4.6	Ta (method 1)	solder bath: 235 °C; 2 s immersed up to 2 mm from the body; non activated flux	no visible damage; marking legible ≥ 95 % tinning
Rapid change of temperature	4.7	Na	5 cycles of 30 min at lower and upper category temperature	no visible damage leakage current tan δ and $Z \leq$ stated limit
Vibration (2)	4.8	Fc	10 Hz to 500 Hz; 0.75 mm or 10 g (whichever is less severe); in 3 directions; 2 h per direction	no visible damage; markings legible $\Delta C/C$: ± 5 % with respect to initial measurement
			128 SAL-RPM: 10 Hz to 2000 Hz; 1.5 mm or 20 g (whichever is less severe); in 3 directions; 2 h per direction	no visible damage; markings legible $\Delta C/C$: ± 5 % with respect to initial measurement
Bump (2)	4.9	Eb	40 g; 2 directions; 4000 bumps total	no visible damage $\Delta C/C$: ± 5 % with respect to initial measurement
Shock (2)	4.10	Ea	123 SAL-AG: acceleration: 29 400 m/s^2 or 3000 g; duration of pulse: 0.2 ms; total number of shocks: 18	no visible damage $\Delta C/C$: ± 5 % with respect to initial measurement

SOLID ALUMINUM TYPES, SAL				
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**IEC 60068-2 TEST METHOD**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Climatic sequence:	4.11			
Dry heat	4.11.1	Ba	16 h at upper category temperature; no voltage applied	
Damp heat, cyclic	4.11.2	Db	1 cycle (55 °C → 25 °C) of 24 h; RH 95 % to 100 %; no voltage applied	
Cold	4.11.3	Aa	2 h at lower category temperature; no voltage applied	no breakdown, flashover, or harmful deformation of case
Low air pressure	4.11.4	M	5 min at 25 °C ± 10 °C; atmospheric pressure: 8.5 kPa; U_R applied during last min of test	
Damp heat, cyclic	4.11.5	Db	5 cycles (55 °C → 25 °C) of 24 h each; 25 °C; RH 95 % to 100 %; no voltage applied	
	4.11.7		final measurements after climatic sequence	no visible damage; markings legible leakage current ≤ stated limit tan δ and Z ≤ 1.2 x stated limit
				axial types: ΔC/C: ± 5 % with respect to initial measurement
				radial types: ΔC/C: ± 10 % with respect to initial measurement
Damp heat, steady state	4.12	Ca	56 d at 40 °C: RH 90 % to 95 %; no voltage applied	no visible damage; markings legible leakage current ≤ stated limit tan δ and Z ≤ 1.2 x stated limit ΔC/C: ± 10 % of initial measurement
Insulation resistance	4.3.5		insulation sleeve: foil method	insulation resistance ≥ 100 MΩ
Voltage proof	4.3.6		insulation sleeve: foil method; 1000 V for 1 min	no breakdown or flashover
Endurance	4.13		for test duration, refer to the relevant datasheet in this data book; at upper category temperature; U_R applied (3)	no visible damage; markings legible leakage current ≤ stated limit ΔC/C: ± 10 % with respect to initial measurement tan δ and Z ≤ 1.2 x stated limit axial types: insulation resistance ≥ 100 MΩ; no breakdown or flashover at 1000 V
Endurance (additional)			2000 h at 175 °C; maximum 0.63 x U_R applied	leakage current ≤ stated limit ΔC/C: ± 20 % with respect to initial measurement tan δ ≤ 1.5 x stated limit Z ≤ 2.5 x stated limit

SOLID ALUMINUM TYPES, SAL				
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**IEC 60068-2 TEST METHOD**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Surge	4.14		applied voltage source of 1.15 x U_R (3) at 125 °C; 1000 cycles; 30 s on, 330 s off	no visible damage leakage current ≤ stated limit tan δ ≤ stated limit
				axial types: ΔC/C: ± 5 % with respect to initial measurement
				radial types: ΔC/C: ± 10 % with respect to initial measurement
Reverse voltage	4.15		0.15 x U_R (3) in reverse polarity at 125 °C for 125 h, followed by U_R (3) in forward polarity at 125 °C for 125 h	leakage current ≤ stated limit ΔC/C: ± 10 % with respect to initial measurement tan δ and Z ≤ stated limit
Reverse voltage (additional): Radial types			0.30 x U_R (3) in reverse polarity at 125 °C for 125 h, followed by U_R (3) in forward polarity at 125 °C for 125 h	leakage current ≤ stated limit ΔC/C: ± 10 % with respect to initial measurement tan δ and Z ≤ stated limit
Reverse voltage (additional): Axial types			0.30 x U_R in reverse polarity at 125 °C for 2000 h	leakage current ≤ stated limit ΔC/C: ± 10 % with respect to initial measurement tan δ and Z ≤ stated limit
Storage at upper category temperature	4.17	Ba	500 h at upper category temperature	no visible damage leakage current ≤ stated limit ΔC/C: ± 10 % with respect to initial measurement
Long storage ≥ 1 year (additional)			at ambient temperature	leakage current ≤ stated limit
Characteristics at high and low temperature	4.19		step 1: reference measurement at 20 °C of capacitance, tan δ and impedance at 100 Hz	
			step 2: measurement at - 55 °C; tan δ and impedance at 100 Hz	ΔC/C: ± 20 % with respect to value in step 1 impedance ratio (100 Hz) ≤ 2 x the value of step 1 tan δ ≤ 2 x the stated limit
			step 3: measurement at 125 °C capacitance, leakage current and tan δ	leakage current ≤ 15 x the stated limit; (4)(5) ΔC/C: ± 20 % of the value measured in step 1 tan δ ≤ stated limit
Charge and discharge	4.20		10^6 cycles charging to U_R for 0.5 s, and then discharging for 0.5 s	no visible damage ΔC/C: ± 5 % with respect to initial measurement

SOLID ALUMINUM TYPES, SAL				
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**IEC 60068-2 TEST METHOD**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Additional tests in accordance with IEC 60384-1 and EN130000				
Solvent resistance	4.31	Xa	immersion: 5 min ± 0.5 min with or without ultrasonic at 55 °C ± 0.5 °C solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
Passive flammability	4.38	IEC 60695-2-2	needle flame test	category of flammability: B

Notes

(1) SPECIAL PLIERS MUST BE USED TO PROTECT THE CELL BODY AND CONSEQUENTLY KEEP THE BENDING LOCATION UNDER CONTROL.

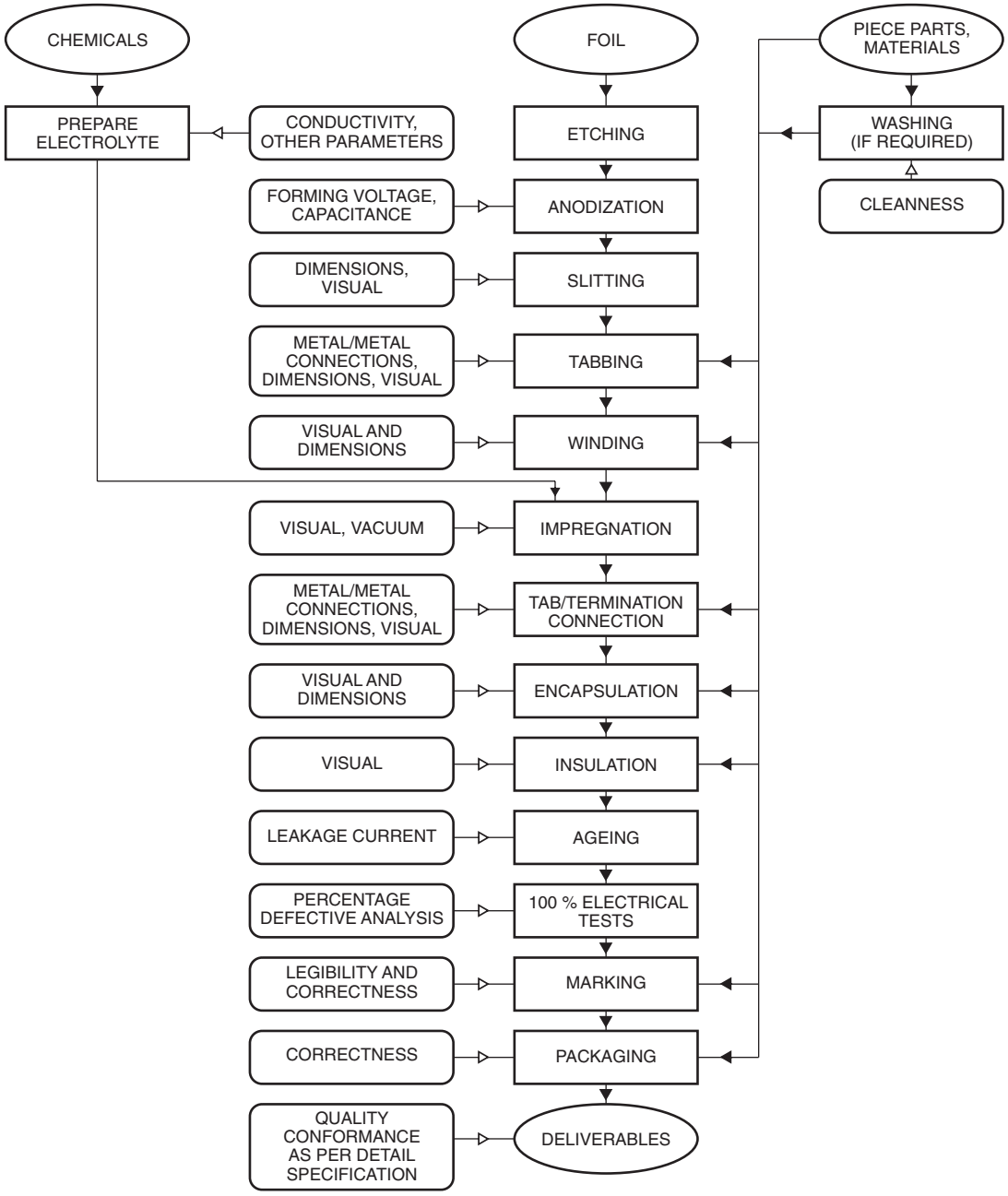
(2) Axial capacitors shall be mounted by clamping both the body and the leads.

(3) U_R at 125 °C is 25 V for 35 V and 40 V versions.

(4) For radial types, 40 V version: < 8 x the stated limit.

(5) Leakage current for axial types: $\leq 1.5 \times U_R \times C_R$.

Generic Quality Flowchart for Non-Solid Electrolytic Capacitors



Lay-out and wording are based on CECC 210 011 (Technology Approval Schedule Electrolytic Capacitors).

Aluminum Capacitors

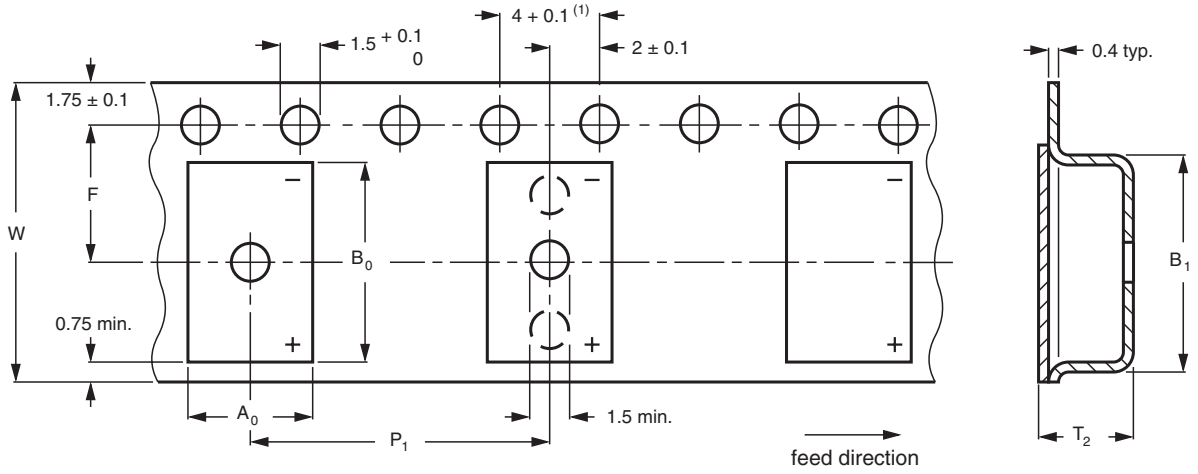
TAPE AND REEL DATA

The information contained within this part is valid for the following series:

- **085 CS**
- **139 CLL**

For catalog numbers, refer to the relevant detail specification in this data book.

Vishay BCcomponents SMD aluminum capacitors are available in taped version based on IEC 60286-3. They are most suitable for use on automatic placement machines and are supplied in blister tape on reel.



(1) Tolerance over any pitches: ± 0.2 mm

Fig.1 Blister tape

Table 1

BLISTER TAPE: DIMENSIONS in millimeters **AND PACKAGING QUANTITIES**					
PARAMETER	**085 CS**		**139 CLL**		**TOLERANCE**
CASE CODE	**1A**	**1**	**2**	**3**	**-**
CASE SIZE					
L_{nom}	8.8	11.9	14.3	14.3	-
W_{nom}	3.7	3.7	6.2	7.6	-
H_{nom}	3.9	3.9	6.9	8.2	-
W	16	24	24	24	± 0.3
T_2	4.9	4.9	7.7	9.1	max.
F	7.5	11.5	11.5	11.5	± 0.1
P_1	8	8	12	12	± 0.1
A_0	4.1	4.1	6.5	7.9	± 0.2
B_0	9.3	12.5	14.8	14.8	± 0.2
B_1	10	13.2	15.5	15.5	max.
Quantity per reel	2000	2000	700	700	-

The information contained within this part is valid for the following series:

- **153 CRV**
- **140 CRH**
- **150 CRZ**

For catalog numbers, refer to the relevant detail specification in this data book.

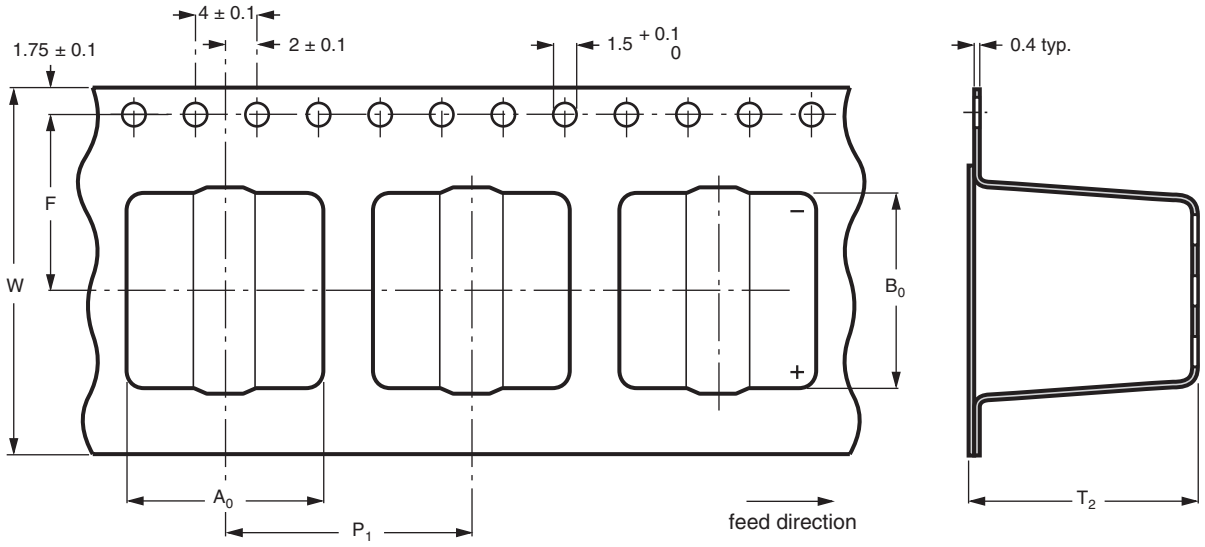


Fig.2 Blister tape

Table 2

BLISTER TAPE: DIMENSIONS in millimeters **AND PACKAGING QUANTITIES**											
PARAMETER	**153 CRV; 140 CRH; 150 CRZ**										**TOLERANCE**
CASE CODE	**0405**	**0505**	**0605**	**0807**	**0810**	**1010**	**1012**	**1014**	**1213**	**1216**	-
CASE SIZE											
L_{nom}	4.0	5.0	6.3	8.0	8.0	10.0	10.0	10.0	12.5	12.5	-
W_{nom}	4.0	5.0	6.3	8.0	8.0	10.0	10.0	10.0	12.5	12.5	-
H_{nom}	5.3	5.3	5.3	6.5	10.0	10.0	12.0	14.0	13.0	16.0	-
W	12	12	16	16	24	24	24	24	24	32	± 0.3
T_2	6.0	6.0	6.0	7.0	11.6	11.6	13.0	14.7	15.5	17.5	max.
F	5.5	5.5	7.5	7.5	11.5	11.5	11.5	11.5	11.5	14.2	± 0.1
P_1	8	12	12	12	16	16	16	16	20	24	± 0.1
A_0	5.0	6.0	7.0	8.7	8.7	10.7	10.8	10.8	13.2	13.2	± 0.2
B_0	5.0	6.0	7.0	8.7	8.7	10.7	10.8	10.8	13.2	13.2	± 0.2
Quantity per reel	2000	1000	1000	1000	500	500	250	250	250	200	-

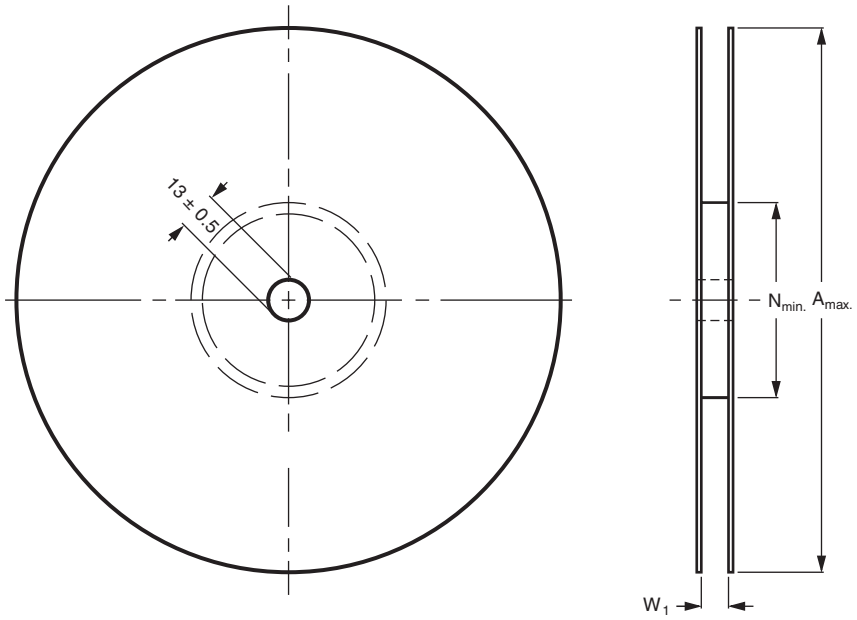


Fig.3 Reel for blister tape

Table 3

REEL DIMENSIONS IN MILLIMETERS					
TAPE WIDTH	$A_{max.}$			$N_{min.}$	W_1
	085 CS 139 CLL	153 CRV; 140 CRH; 150 CRZ			
		CASE SIZE 1012, 1014	CASE SIZE ≤ 1216		
12	-	-	380	50	14
16	330	-	380	50	18
24	330	330	330 or 380 (1)	50	26
32	-	-	380	50	34

Note

(1) Depending on production location

Aluminum Capacitors

TAPING

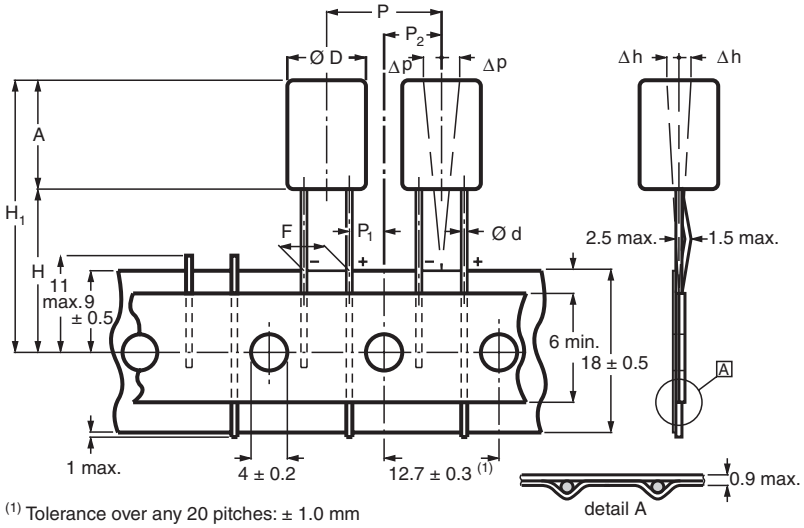
BCcomponents radial, aluminum and solid aluminum capacitors in sizes up to Ø D = 16 mm, are available in taped versions corresponding to *"IEC 60286-2"* or *"JIS C 0805"* respectively. They are most suitable for use on automatic insertion machines, mounting robots or cutting and forming equipment and are supplied in boxes (ammopacks).

CAUTION
Packages must be handled with care to avoid bent leads

The information contained within this part is valid for the following series:

- **013 RLC**
- **036 RSP**
- **116 RLL**

For catalog numbers, refer to the relevant detail specification in this data book.



(1) Tolerance over any 20 pitches: ± 1.0 mm

Fig.1 **Form TNA and TFA**, straight leads

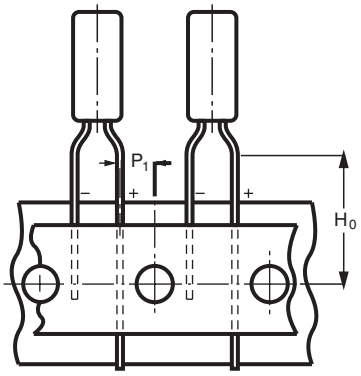


Fig.2 **Form TFA**, formed leads

Table 1

DIMENSIONS in millimeters				
PARAMETER	**NOMINAL CASE SIZE (Ø D x L)**			**TOLERANCE**
	FORM TNA: F = 2.5	**FORM TFA: F = 5**		
	5 x 11 (straight leads)	**5 x 11 (formed leads)**	**8.2 x 11 (straight leads)**	
Ø D	5.5	5.5	8.7	max.
A	12	12	12	max.
Ø d	0.5	0.5	0.6	± 0.05
P	12.7	12.7	12.7	± 1.0
P_1	5.1	3.85	3.85	± 0.7
P_2	6.35	6.35	6.35	± 0.7
F	2.5	5.0	5.0	+ 0.6/- 0.1
Δh	0	0	0	± 2.0
Δp	0	0	0	± 1.3
H	18	18	18	+ 1.5/- 0
H_0	-	16	-	± 0.5
H_1	32	32	32	max.

Table 2

QUANTITIES PER PACKAGING UNIT					
NOMINAL CASE SIZE (Ø D x L) (mm)	CASE CODE	BULK PER BOX		TAPED AMMOPACK (1)	
		FORM CA	FORM CB	FORM TFA	FORM TNA
5 x 11	11	1000	1000	2000	2000
8.2 x 11	13	1000	1000	1000	1000

Note

(1) Ammopack taping (Form TFA) case Ø D x L = 8.2 x 11 mm. To ensure optimum straightness of the leads and correct position of the capacitors in the folding area of the zig-zag shaped tape, every 25 th capacitor is omitted.

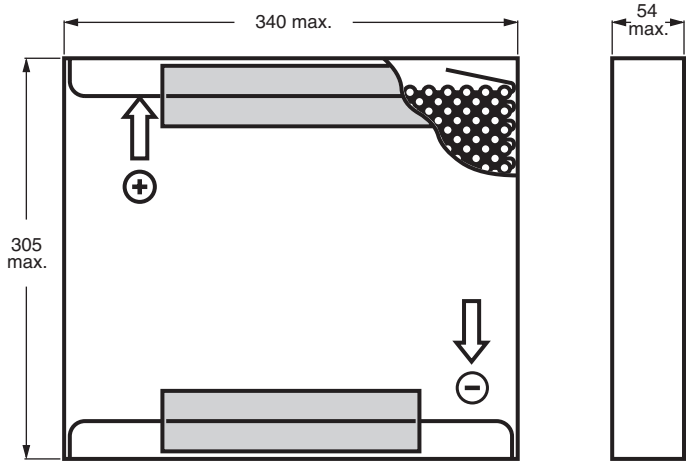
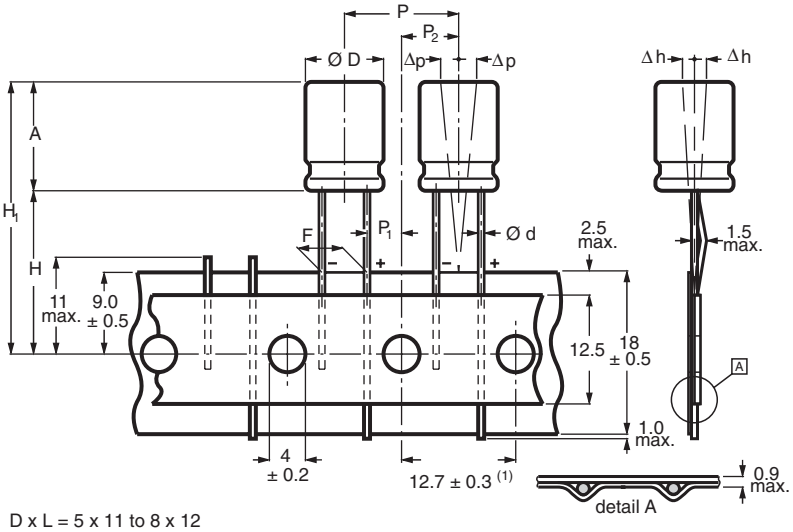


Fig.3 Ammopack; **Forms TFA and TNA**

The information contained within this part is valid for the following series with a case Ø D = 4 to 8 mm:

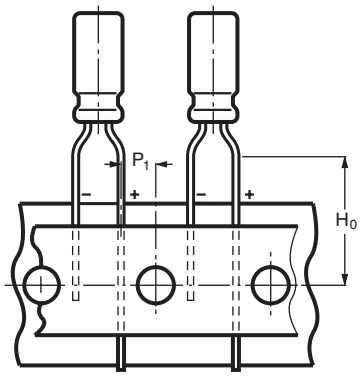
- **134 RLP 5**
- **097 RLP 7**
- **038 RSU**
- **150 RMI**



D x L = 5 x 11 to 8 x 12

(1) Tolerance over any 20 pitches: ± 1.0 mm

Fig.4 **Form TNA**, straight leads



D x L = 5 x 11 to 8 x 12

Fig.5 **Form TFA**, formed leads

Table 3

DIMENSIONS in millimeters									
PARAMETER	**NOMINAL CASE SIZE (Ø D x L) in mm**								**TOLERANCE**
	FORM TNA				**FORM TFA**				
	5 x 11	**6.3 x 11**	**8 x 12**	**8 x 15**	**5 x 11**	**6.3 x 11**	**8 x 12**	**8 x 15**	
Ø D	5.5	6.8	8.5	8.5	5.5	6.8	8.5	8.5	max.
A	12.5	12.5	13.0	16.0	12.5	12.5	13.0	16.0	max.
Ø d	0.5	0.5	0.6	0.6	0.5	0.5	0.6	0.6	± 0.05
P	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	± 1.0
P_1	5.1	5.1	4.6	4.6	3.85	3.85	3.85	3.85	± 0.7
P_2	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	± 1.0
F	2.5	2.5	3.5	3.5	5.0	5.0	5.0	5.0	+ 0.8/- 0.2
Δh	0	0	0	0	0	0	0	0	± 2.0
Δp	0	0	0	0	0	0	0	0	± 1.3
H	18.5	18.5	18.5	18.5	18.5	18.5	20.0	20.0	± 0.75
H_0	-	-	-	-	16.0	16.0	16.0	16.0	± 0.5
H_1	32.2	32.2	32.2	35.2	32.2	32.2	33.7	36.7	max.

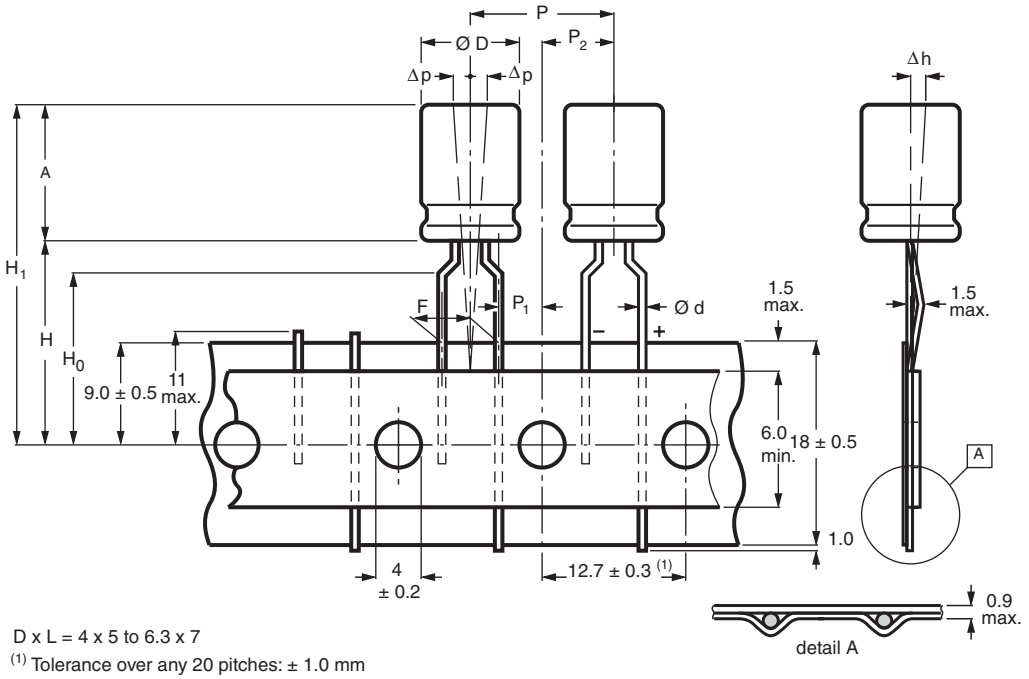


Fig.6 Form **TFA and TNA**

Table 4

DIMENSIONS in millimeters							
PARAMETER	NOMINAL CASE SIZE (Ø D x L)						TOLERANCE
	FORM TFA						
	4 x 5	5 x 5	6.3 x 5	4 x 7	5 x 7	6.3 x 7	
Ø D	4.5	5.5	6.8	4.5	5.5	6.8	max.
A	6.0	6.0	6.0	8.0	8.0	8.0	max.
Ø d	0.45	0.45	0.45	0.45	0.45	0.45	± 0.05
P	12.7	12.7	12.7	12.7	12.7	12.7	± 1.0
P_1	3.85	3.85	3.85	3.85	3.85	3.85	± 0.7
P_2	6.35	6.35	6.35	6.35	6.35	6.35	± 1.0
F	5.0	5.0	5.0	5.0	5.0	5.0	+ 0.8/- 0.2
Δh	0	0	0	0	0	0	± 2.0
Δp	0	0	0	0	0	0	± 1.3
H	17.5	17.5	17.5	17.5	17.5	17.5	± 0.75
H_0	16	16	16	16	16	16	± 0.5
H_1	32.2	32.2	32.2	32.2	32.2	32.2	max.

Table 5

DIMENSIONS in millimeters							
PARAMETER	**NOMINAL CASE SIZE (Ø D x L)**						**TOLERANCE**
	FORM TNA						
	4 x 5	**5 x 5**	**6.3 x 5**	**4 x 7**	**5 x 7**	**6.3 x 7**	
Ø D	4.5	5.5	6.8	4.5	5.5	6.8	max.
A	6.0	6.0	6.0	8.0	8.0	8.0	max.
Ø d	0.45	0.45	0.45	0.45	0.45	0.45	± 0.05
P	12.7	12.7	12.7	12.7	12.7	12.7	± 1.0
P_1	5.1	5.1	5.1	5.1	5.1	5.1	± 0.7
P_2	6.35	6.35	6.35	6.35	6.35	6.35	± 1.0
F	2.5	2.5	2.5	2.5	2.5	2.5	+ 0.8/- 0.2
Δh	0	0	0	0	0	0	± 2.0
Δp	0	0	0	0	0	0	± 1.3
H	17.5	18.5	18.5	17.5	18.5	18.5	± 0.75
H_0	16	-	-	-	-	-	± 0.5
H_1	32.2	32.2	32.2	32.2	32.2	32.2	max.

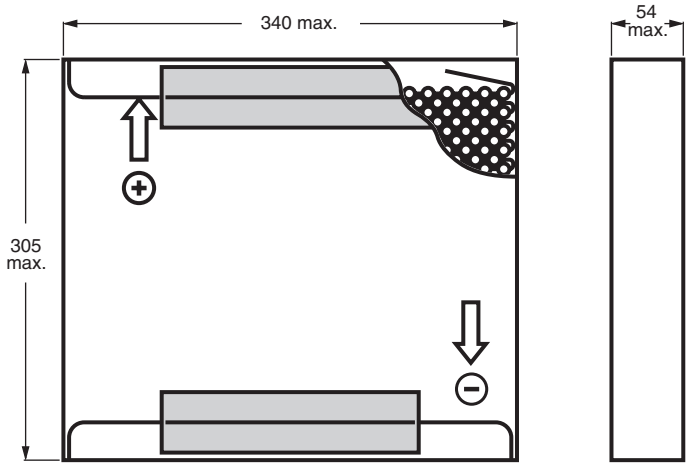
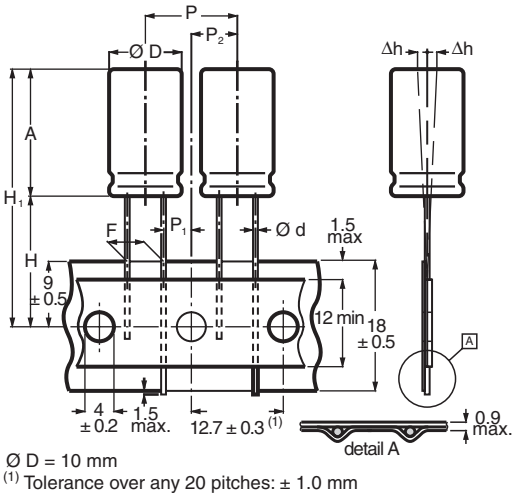


Fig.7 Ammopack; **Form TFA and TNA**

The information contained in this part is valid for the following series with a case Ø D = 10 to 16 mm:

- **038 RSU**
- **048 RML**
- **136 RVI**
- **150 RMI**
- **152 RMH**
- **140 RTM**
- **148 RUS**



(1) Tolerance over any 20 pitches: ± 1.0 mm

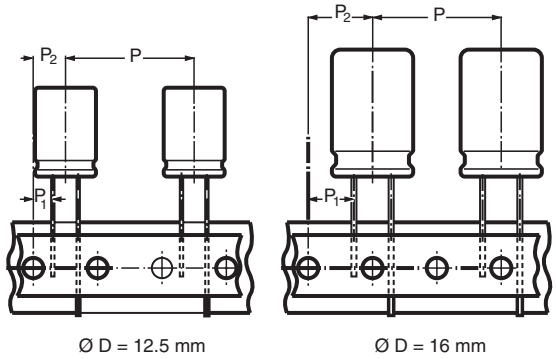


Fig.8 **Form TFA**

Table 6

DIMENSIONS in millimeters									
PARAMETER	**NOMINAL CASE SIZE (Ø D x L)**								**TOLERANCE**
	10 x 12	**10 x 16**	**10 x 20**	**12.5 x 20**	**12.5 x 25**	**16 x 20**	**16 x 25**	**16 x 31**	
Ø D	10.5	10.5	10.5	13.0	13.0	16.5	16.5	16.5	max.
A	13.5	17.5	22	22	27	22	27	33.5	max.
Ø d	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	± 0.05
P	12.7	12.7	12.7	25.4	25.4	25.4	25.4	25.4	± 1.0
P_1	3.85	3.85	3.85	3.85	3.85	8.95	8.95	8.95	± 0.7
P_2	6.35	6.35	6.35	6.35	6.35	12.7	12.7	12.7	± 1.3
F	5.0	5.0	5.0	5.0	5.0	7.5	7.5	7.5	+ 0.8/- 0.2
Δh	0	0	0	0	0	0	0	0	± 3.0
H	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	± 0.75
H_1	$H_1 = H + A$								
B	54	62	62	62	68	68	68	75	max.

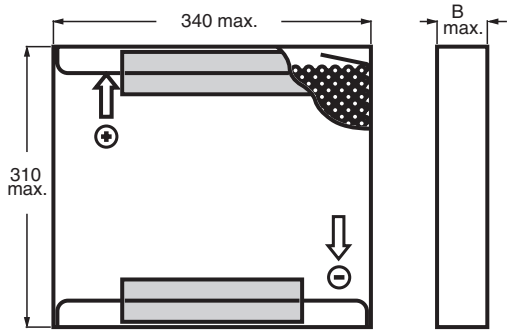


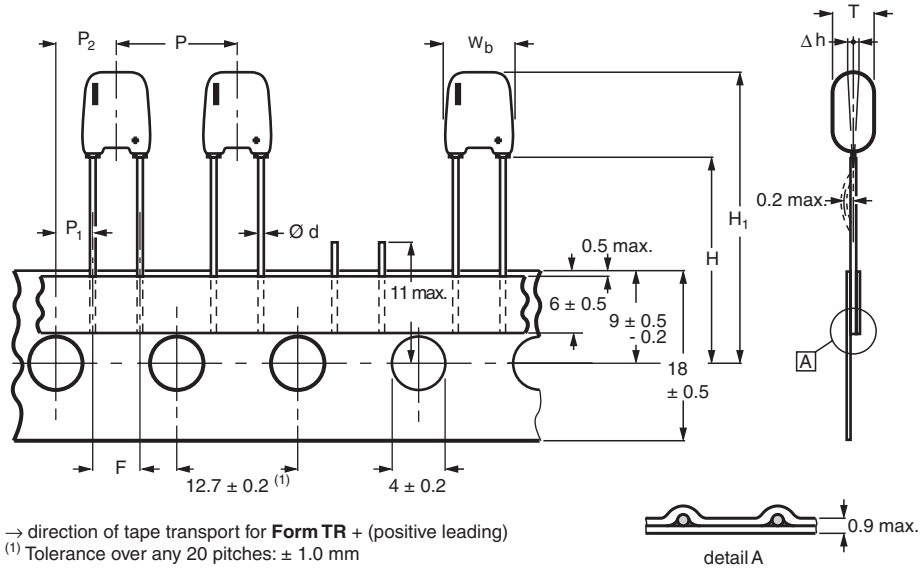
Fig.9 Ammopack; **Form TFA**

Note

(1) Ammopack taping (Form TFA). To ensure optimum straightness of the leads and correct position of the components in the folding area of the zig-zag shaped tape, where necessary, one capacitor is omitted at each folding edge.

The information contained within this part is valid for the following series:

- **128 SAL-RPM**

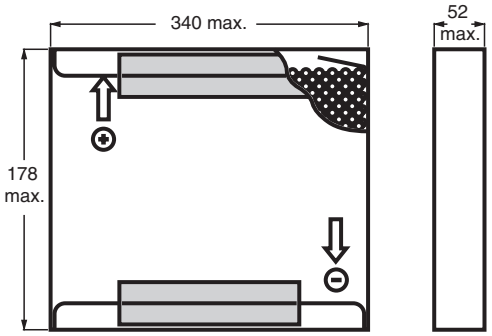


→ direction of tape transport for **Form TR** + (positive leading)
(1) Tolerance over any 20 pitches: ± 1.0 mm

Fig.10 Capacitors on tape

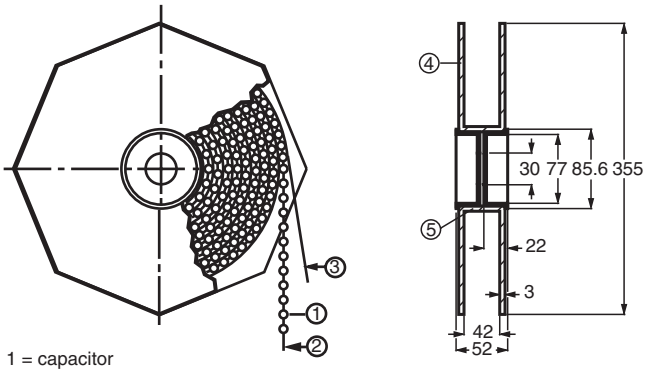
Table 7

TAPING DIMENSIONS in millimeters							
PARAMETER	**128 SAL-RPM MAX. HEIGHT 9.5 mm**						**TOLERANCE**
	CASE CODE						
	10	**20**	**30**	**40**	**50**	**60**	
T	3.0	3.5	4.0	5.0	5.0	6.0	max.
W_b	7.0	7.0	7.0	7.0	8.0	8.0	max.
Ø d	0.6	0.6	0.6	0.6	0.6	0.6	+ 0.02/- 0
P	12.7	12.7	12.7	12.7	12.7	12.7	± 1.0
P_1	3.85	3.85	3.85	3.85	3.85	3.85	± 0.7
P_2	6.35	6.35	6.35	6.35	6.35	6.35	± 1.0
F	5.2	5.2	5.2	5.2	5.2	5.2	± 0.2
Δh	0	0	0	0	0	0	± 1.0
H	18.5	18.5	18.5	18.5	18.5	18.5	± 0.75
H_1	28	28	28	28	28	28	max.



preferred packaging

Fig.11 Ammopack; **Form TFA**



1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder

Fig.12 Reel; **Form TR+**

Table 8

QUANTITIES PER PACKAGING UNIT					
CASE SIZE $H_{max.}$ x $W_{max.}$ x $T_{max.}$ (mm)	CASE CODE	BULK PER BOX		TAPED PER REEL	TAPED PER BOX
		FORM CA	FORM CB	FORM TR+	FORM TFA
9.5 x 7.0 x 3.0	10	1000	1000	1000	1000
9.5 x 7.0 x 3.5	20	1000	1000	1000	1000
9.5 x 7.0 x 4.0	30	1000	1000	1000	1000
9.5 x 7.0 x 5.0	40	1000	1000	1000	1000
9.5 x 8.0 x 5.0	50	1000	1000	1000	1000
9.5 x 8.0 x 6.0	60	1000	1000	1000	1000

Aluminum Capacitors

TAPING

Vishay BCcomponents axial, aluminum and solid aluminum capacitors in sizes up to Ø D = 16 mm, are available in taped version corresponding to *"IEC 60286-1"*.

They are most suitable for use on automatic insertion machines, cutting and forming equipment and are supplied in box (ammopack preferred), or on reel.

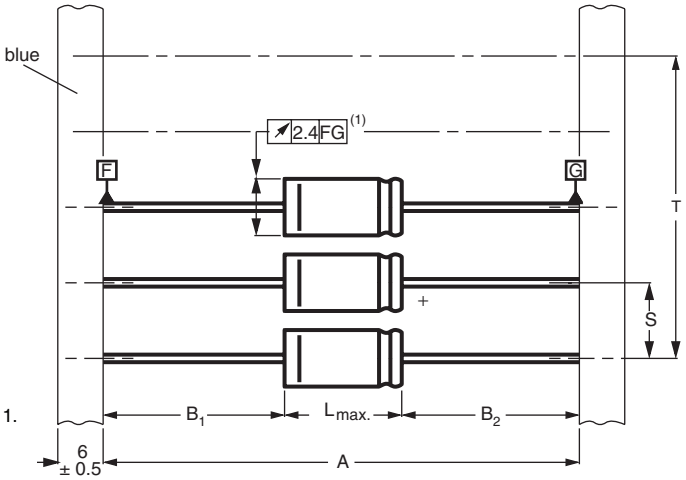
CAUTION
Packages must be handled with care to avoid bent leads

Table 1

TAPING DIMENSIONS in millimeters							
NOMINAL CASE SIZE (Ø D x L)	**A**	**S**	**T FOR NUMBER (n)**		$L_{max.}$	**C**	**D**
			n < 50	**50 < n < 100**			
NON-SOLID TYPES							
3.3 x 8	63.5 ± 1.5 (1)	5 ± 0.4	5 (n-1) ± 2	5 (n-1) ± 4	9	83.5	94.5
3.3 x 11	63.5 ± 1.5 (1)	5 ± 0.4	5 (n-1) ± 2	5 (n-1) ± 4	12	83.5	94.5
4.5 x 10	63.5 ± 1.5 (1)	5 ± 0.4	5 (n-1) ± 2	5 (n-1) ± 4	10.5	83.5	94.5
6 x 10	63.5 ± 1.5 (1)	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	10.5	83.5	94.5
6.3 x 12.7	63.5 ± 1.5 (1)	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	12.9	83.5	94.5
7.7 x 12.7	63.5 ± 1.5 (1)	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	12.9	83.5	94.5
8 x 11	63.5 ± 1.5 (1)	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	11.5	83.5	94.5
6.5 x 18	73 ± 1.6 (1)	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	18.5	88.5	99.5
8 x 18	73 ± 1.6 (1)	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	18.5	88.5	99.5
10 x 18	73 ± 1.6 (1)	15 ± 0.75	15 (n-1) ± 2	15 (n-1) ± 4	18.5	88.5	99.5
10 x 25	73 ± 1.6	15 ± 0.75	15 (n-1) ± 2	15 (n-1) ± 4	25.0	88.5	99.5
10 x 30	73 ± 1.6	15 ± 0.75	15 (n-1) ± 2	15 (n-1) ± 4	30.5	90	100
12.5 x 30	73 ± 1.6	15 ± 0.75	15 (n-1) ± 2	15 (n-1) ± 4	30.5	90	100
15 x 30	73 ± 1.6	20 ± 0.75	20 (n-1) ± 2	20 (n-1) ± 4	30.5	90	100
SOLID TYPES							
6.5 x 15	73 ± 1.6	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	15.3	90	100
7.5 x 20	73 ± 1.6	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	20.4	90	100
9 x 22.5	73 ± 1.6	10 ± 0.4	10 (n-1) ± 2	10 (n-1) ± 4	23.3	90	100
10 x 31.5	73 ± 1.6	15 ± 0.75	15 (n-1) ± 2	15 (n-1) ± 4	32	90	100
12.5 x 31.5	73 ± 1.6	15 ± 0.75	15 (n-1) ± 2	15 (n-1) ± 4	32	90	100

Note

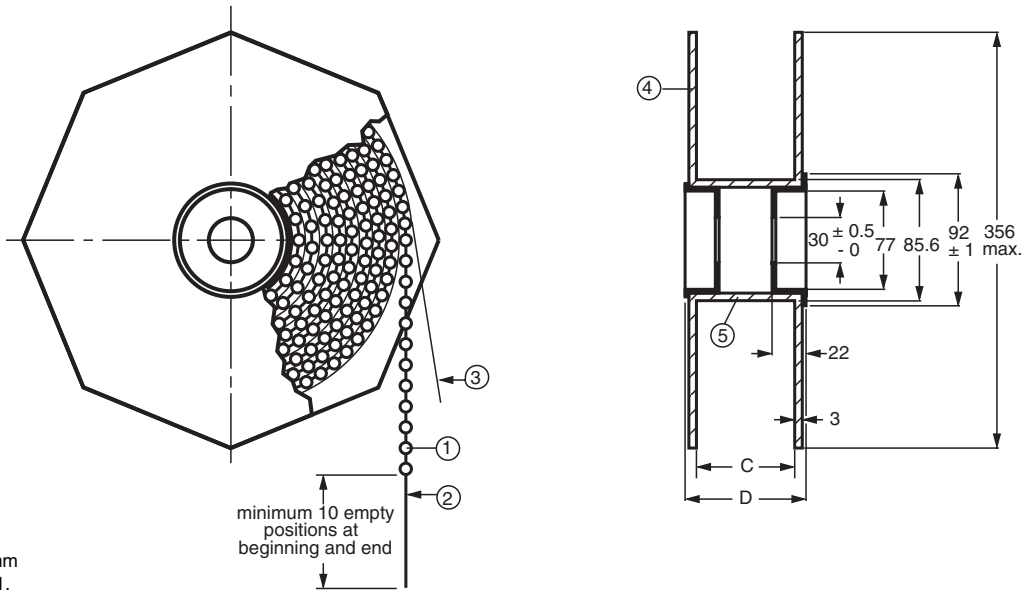
(1) 52 ± 1.5 mm on request



Dimensions in mm
Case Ø D x L = 3.3 x 8 to 16 x 30 mm
B_1 - B_2 = max. 1.4 mm
The negative capacitor terminals are connected to the blue tape.
For dimensions A, S, T and L, see Table 1.

Note
(1) Not for case Ø D x L = 15 x 30 mm

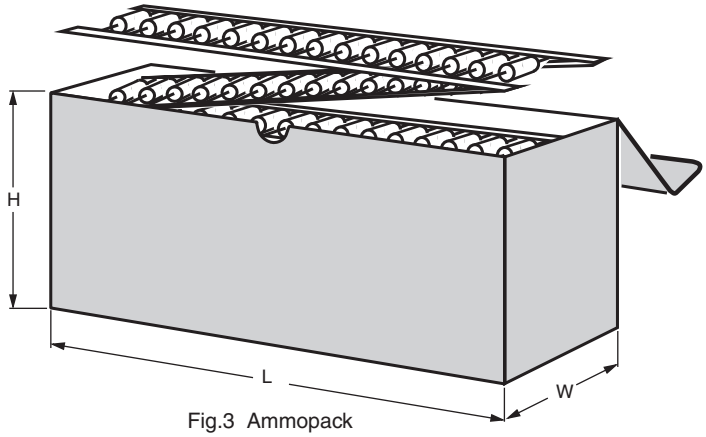
Fig.1 Axial capacitors on tape



1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder

Dimensions in mm
Case Ø D x L = 3.3 x 8 to 16 x 30 mm
For dimensions C and D see Table 1.

Fig.2 Reel dimensions



Preferred packaging
Case Ø D x L = 3.3 x 8 to 16 x 30 mm
For dimensions L, W and H see Table 2.

Fig.3 Ammopack

Table 2

AMMOPACK: DIMENSIONS in millimeters			
NOMINAL CASE SIZE (Ø D x L)	**L**	**W**	**H**
NON-SOLID TYPES			
3.3 x 8	282	92	64
3.3 x 11	282	92	64
4.5 x 10	282	92	90
6 x 10	420	92	107
6.3 x 12.7	420	92	130
7.7 x 12.7	420	92	107
8 x 11	420	92	107
6.5 x 18	420	98	130
8 x 18	420	98	100
10 x 18	420	98	159
10 x 25	420	98	159
12 x 30	386	101	301
15 x 30	386	101	301

Table 3

QUANTITIES PER PACKAGING UNIT				
NOMINAL CASE SIZE (Ø D x L) (mm)	**AXIAL**			**MOUNTING RING (BULK) FORM MR**
	TAPED IN AMMOPACK FORM BA	**TAPED ON REEL FORM BR**	**BULK OR PAPERSTRIP FORM AA**	
NON-SOLID TYPES				
3.3 x 8	1000	4000	-	-
3.3 x 11	1000	4000	-	-
4.5 x 10	1000	3000	-	-
6 x 10	1000	1000	-	-
6.3 x 12.7	1000	1000	-	-
7.7 x 12.7	500	500	-	-
8 x 11	500	500	-	-
6.5 x 18	1000	1000	-	-
8 x 18	500	500	-	-
10 x 18	500	500	-	-
10 x 25	500	500	-	-
10 x 30	-	500	340	-
12.5 x 30	-	400	260	-
15 x 30	-	250	200	200
18 x 30	-	-	120	240
18 x 38	-	-	125	100
21 x 38	-	-	100	100
SOLID TYPES				
6.5 x 15	-	800	100	-
7.5 x 20	-	800	100	-
9 x 22.5	-	500	100	-
10 x 31.5	-	500	100	-
12.5 x 31.5	-	400	100	-

Aluminum Capacitors
SMD (Chip) Long Life Vertical

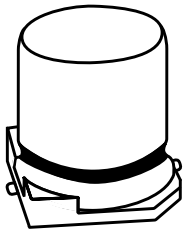
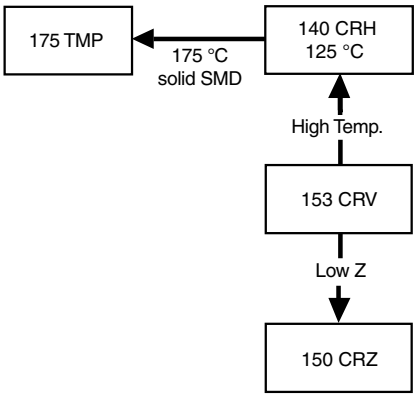


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing
- SMD-version with base plate, vertical construction requiring minimum board space, lead (Pb)-free reflow solderable
- High CV per unit volume
- Long useful life: 2000 to 3000 h at 105 °C
- Charge and discharge proof, no peak current limitation
- Supplied in blister tape on reel
- Lead (Pb)-free and RoHS compliant
- ATTENTION: for maximum safe soldering conditions refer to Fig.4

Pb-free

RoHS COMPLIANT

APPLICATIONS

- SMD technology, in compliance with RoHS
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Telecommunications, general industrial, EDP, automotive, portable and lightweight equipment

MARKING

- Rated capacitance (in µF)
- Rated voltage (in V)
- Date code
- Black mark or '-' sign indicating the cathode (the anode is identified by bevelled edges)

PACKAGING

- Supplied in blister tape on reel

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (L x W x H in mm)	4.0 x 4.0 x 5.3 to 10 x 10 x 14
Rated capacitance range, C_R	0.47 to 1000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	- 55 to + 105 °C
Endurance test at 105 °C:	
case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3	1000 hours
case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14	2000 hours
Useful life at 105 °C:	
case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3	2000 hours
case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14	3000 hours
Useful life at 40 °C; 1.3 x I_R applied:	
case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3	200 000 hours
case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14	300 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-18/ CECC 32300
Climatic category IEC 60068	55/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm)								
C_R (µF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
0.47	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
1.0	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
2.2	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
3.3	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
4.7	-	-	-	-	4.0 x 4.0 x 5.3	5.0 x 5.0 x 5.3	-	-
10	-	-	4.0 x 4.0 x 5.3	-	5.0 x 5.0 x 5.3	6.3 x 6.3 x 5.3	-	10 x 10 x 12
22	4.0 x 4.0 x 5.3	-	5.0 x 5.0 x 5.3	-	6.3 x 6.3 x 5.3	8.0 x 8.0 x 6.5	-	10 x 10 x 12
33	-	5.0 x 5.0 x 5.3	-	6.3 x 6.3 x 5.3	8.0 x 8.0 x 6.5	8.0 x 8.0 x 10	-	10 x 10 x 14
47	5.0 x 5.0 x 5.3	-	6.3 x 6.3 x 5.3	8.0 x 8.0 x 6.5	-	8.0 x 8.0 x 10	10 x 10 x 12	-
100	6.3 x 6.3 x 5.3	-	8.0 x 8.0 x 6.5	8.0 x 8.0 x 10	-	10 x 10 x 10	10 x 10 x 14	-
	-	-	-	-	-	10 x 10 x 12	-	-
220	-	8.0 x 8.0 x 10	10 x 10 x 10	10 x 10 x 12	10 x10 x 12	-	-	-
330	8.0 x 8.0 x 10	10 x 10 x 10	10 x 10 x 12	10 x 10 x 14	-	-	-	-
470	10 x 10 x 10	10 x 10 x 12	10 x 10 x 14	-	-	-	-	-
680	10 x 10 x 12	10 x 10 x 14	-	-	-	-	-	-
1000	10 x 10 x 14	-	-	-	-	-	-	-

Table 1

TAPE AND REEL DIMENSIONS in millimeters AND PACKAGING QUANTITIES					
CASE CODE	PITCH P_1	TAPE WIDTH W	TAPE THICKNESS T_2	REEL DIAMETER	PACKAGING QUANTITY PER REEL
0405	8	12	5.8	380	2000
0505	12	12	5.8	380	1000
0605	12	16	5.8	380	1000
0807	12	16	6.8	380	1000
0810	16	24	11.3	380	500
1010	16	24	11.3	380	500
1012	16	24	12.8	330	250
1014	16	24	14.8	330	250

Note

Detailed tape dimensions see section 'PACKAGING'.

Table 2

DIMENSIONS in millimeters **AND MASS**								
NOMINAL CASE SIZE L x W x H	**CASE CODE**	**$L_{max.}$**	**$W_{max.}$**	**$H_{max.}$**	**Ø D**	**$B_{max.}$**	**S**	**MASS (g)**
4.0 x 4.0 x 5.3	0405	4.5	4.5	5.5	4.0	0.8	1.0	≈ 0.13
5.0 x 5.0 x 5.3	0505	5.5	5.5	5.5	5.0	0.8	1.4	≈ 0.20
6.3 x 6.3 x 5.3	0605	6.8	6.8	5.5	6.3	0.8	2.0	≈ 0.30
8.0 x 8.0 x 6.5	0807	8.6	8.6	6.8	8.0	0.8	2.3	≈ 0.50
8.0 x 8.0 x 10	0810	8.6	8.6	10.5	8.0	1.1	3.1	≈ 1.00
10 x 10 x 10	1010	10.6	10.6	10.5	10.0	1.1	4.7	≈ 1.30
10 x 10 x 12	1012	10.6	10.6	12.3	10.0	1.2	4.5	≈ 1.40
10 x 10 x 14	1014	10.6	10.6	14.3	10.0	1.2	4.5	≈ 1.50

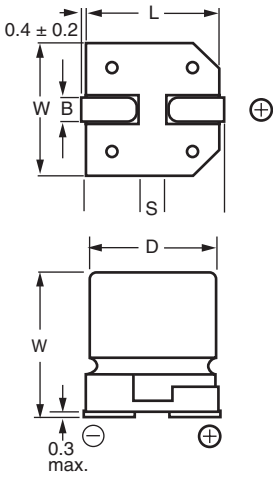


Fig.2 Dimensional outline

MOUNTING

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and/or adjacent components.

For recommended soldering pad dimensions, refer to Fig.3 and Table 3.

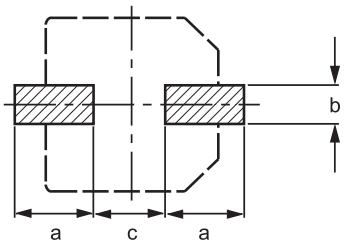


Fig.3 Recommended soldering pad dimensions

SOLDERING

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the soldering pad and on top of the case during processing.

For maximum conditions refer to Fig.4.
Maximum 2 runs with pause of minimum 30 min between.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

AS A GENERAL PRINCIPLE, TEMPERATURE AND DURATION SHALL BE THE **MINIMUM** NECESSARY REQUIRED TO ENSURE GOOD SOLDERING CONNECTIONS. HOWEVER, THE SPECIFIED MAXIMUM CURVES SHOULD NEVER BE EXCEEDED.

Table 3

RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters			
CASE CODE	**a**	**b**	**c**
0405	2.6	1.6	1.0
0505	3.0	1.6	1.4
0605	3.5	1.6	1.9
0807	4.0	1.6	2.1
0810	3.5	2.5	3.0
1010	4.0	2.5	4.0
1012	4.3	2.5	4.0
1014	4.3	2.5	4.0

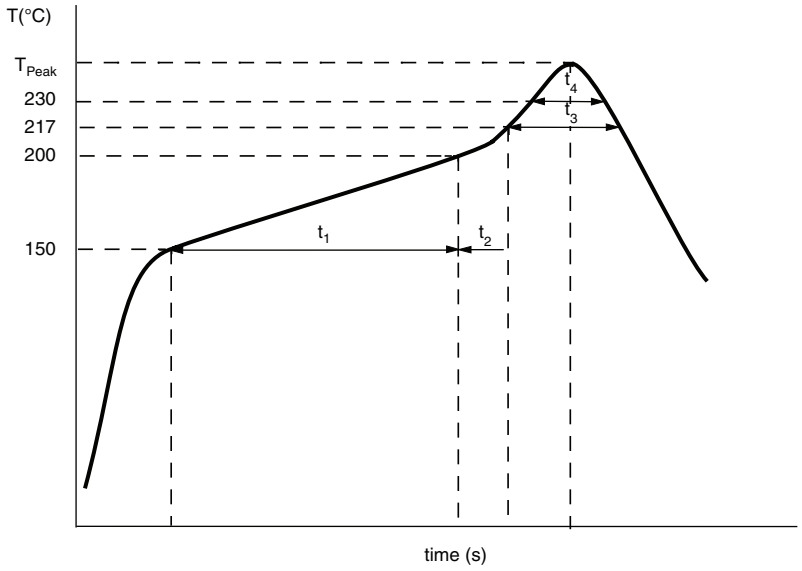


Fig.4 Maximum temperature load during reflow soldering measured on capacitors soldering pad and top of the case

REFLOW SOLDERING CONDITIONS				
PROFILE FEATURES	**CASE CODE 0405 to 0605**	**CASE CODE 0807 to 1010**	**CASE CODE 1012 to 1014 ≤ 63 V**	**CASE CODE 1012 to 1014 100 V**
Max. time from 25 °C to T_{peak}	240 s	240 s	300 s	270 s
Max. ramp-up rate to 150 °C	3 K/s	3 K/s	3 K/s	3 K/s
Max. time from 150 °C to 200 °C (t1)	120 s	120 s	150 s	120 s
Ramp up rate from 200 °C to T_{peak}	0.5 K/s to 3 K/s	0.5 K/s to 3 K/s	0.5 K/s to 3 K/s	0.5 K/s to 3 K/s
Max. time from 200 °C - 217 °C, (t2)	20 s	20 s	60 s	60 s
Max. time above $T_{Liquidus}$ (217 °C), (t3)	60 s	60 s	90 s	60 s
Max. time above 230 °C (t4)	30 s	20 s	40 s	30 s
Peak temperature T_{peak}	250 °C	240 °C	250 °C	240 °C
Max. time above T_{peak} minus 5 °C	5 s	5 s	5 s	10 s
Max. ramp-down rate from $T_{Liquidus}$	6 K/s	6 K/s	6 K/s	6 K/s

Note
Temperature measuring point on top of the case and terminals max. 2 runs with pause of 30 minutes in between

ELECTRICAL DATA

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 or 120 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 or 120 Hz, 105 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 or 120 Hz
ESR	equivalent series resistance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 153 CRV series

100 µF/25 V; ± 20 %

Nominal case size:
8 x 8 x 10 mm; taped on reel

Ordering Code: MAL215376101E3

Former 12NC: 2222 153 76101

Table 4

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R (µF)	NOMINAL CASE SIZE L x W x H (mm)	I_R 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	ESR 100 kHz (Ω)	ORDERING CODE MAL2153.....
6.3	22	4.0 x 4.0 x 5.3	21	3.0	0.30	8	73229E3
	47	5.0 x 5.0 x 5.3	36	3.0	0.30	4	73479E3
	100	6.3 x 6.3 x 5.3	61	6.3	0.30	2	73101E3
	330	8.0 x 8.0 x 10	180	21	0.30	0.5	73331E3
	470	10 x 10 x 10	320	30	0.30	0.3	73471E3
	680	10 x 10 x 12	340	43	0.24	0.29	73681E3
	1000	10 x 10 x 14	400	63	0.24	0.24	73102E3
10	33	5.0 x 5.0 x 5.3	31	3.3	0.26	4	74339E3
	220	8.0 x 8.0 x 10	180	22	0.26	0.5	74221E3
	330	10 x 10 x 10	320	33	0.26	0.3	74331E3
	470	10 x 10 x 12	330	47	0.19	0.29	74471E3
	680	10 x 10 x 14	380	68	0.19	0.24	74681E3
16	10	4.0 x 4.0 x 5.3	16	3.0	0.22	8	75109E3
	22	5.0 x 5.0 x 5.3	28	3.5	0.22	4	75229E3
	47	6.3 x 6.3 x 5.3	47	7.5	0.22	2.2	75479E3
	100	8.0 x 8.0 x 6.5	110	16	0.22	1.2	75101E3
	220	10 x 10 x 10	320	35	0.22	0.3	75221E3
	330	10 x 10 x 12	330	53	0.16	0.29	75331E3
	470	10 x 10 x 14	370	75	0.16	0.25	75471E3
25	33	6.3 x 6.3 x 5.3	44	8.3	0.16	2.2	76339E3
	47	8.0 x 8.0 x 6.5	110	12	0.16	1.2	76479E3
	100	8.0 x 8.0 x 10	180	22	0.16	0.5	76101E3
	220	10 x 10 x 12	270	55	0.14	0.29	76221E3
	330	10 x 10 x 14	300	83	0.14	0.27	76331E3
35	4.7	4.0 x 4.0 x 5.3	14	3.0	0.13	8	70478E3
	10	5.0 x 5.0 x 5.3	23	3.5	0.13	4	70109E3
	22	6.3 x 6.3 x 5.3	50	7.7	0.13	2.2	70229E3
	33	8.0 x 8.0 x 6.5	110	12	0.13	1.2	70339E3
	220	10 x 10 x 12	270	77	0.12	0.29	70221E3
50	0.47	4.0 x 4.0 x 5.3	5	3.0	0.12	12	71477E3
	1.0	4.0 x 4.0 x 5.3	7	3.0	0.12	12	71108E3
	2.2	4.0 x 4.0 x 5.3	10	3.0	0.12	12	71228E3
	3.3	4.0 x 4.0 x 5.3	12	3.0	0.12	12	71338E3
	4.7	5.0 x 5.0 x 5.3	17	3.0	0.12	6	71478E3
	10	6.3 x 6.3 x 5.3	26	5.0	0.12	3	71109E3
	22	8.0 x 8.0 x 6.5	110	11	0.12	1.2	71229E3
	33	8.0 x 8.0 x 10	180	17	0.12	0.5	71339E3
	47	8.0 x 8.0 x 10	180	24	0.12	0.5	71479E3
	100	10 x 10 x 10	320	50	0.12	0.3	71101E3
	100	10 x 10 x 12	230	50	0.12	0.29	91107E3
63	47	10 x 10 x 12	220	30	0.09	0.39	78479E3
	100	10 x 10 x 14	240	63	0.09	0.34	78101E3
100	10	10 x 10 x 12	150	10	0.07	1.4	79109E3
	22	10 x 10 x 12	150	25	0.07	1.4	79229E3
	33	10 x 10 x 14	170	33	0.07	1.3	79339E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage	IEC 6084-18, subclause 4.14	$U_s \leq 1.15 \times U_R$
Reverse voltage	IEC 60384-18, subclause 4.16	$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA, whichever is greater
Inductance		
Equivalent series inductance (ESL)	Case codes 0405 to 0605	typ. 10 nH
	Case codes 0807 to 1014	typ. 15 nH

CAPACITANCE (C)

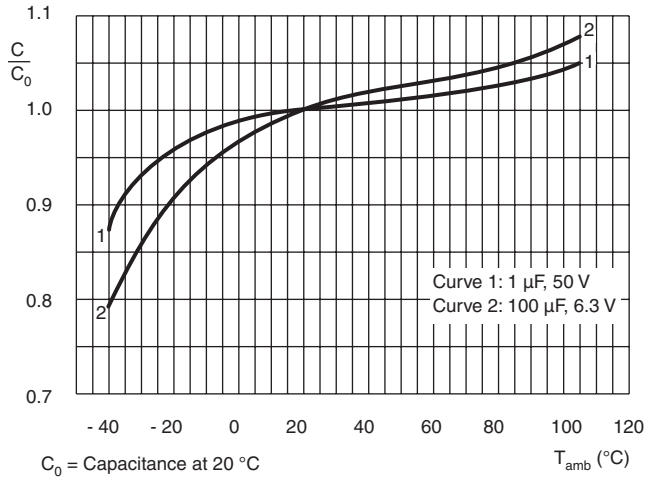


Fig.5 Typical multiplier of capacitance at 100 or 120 Hz as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

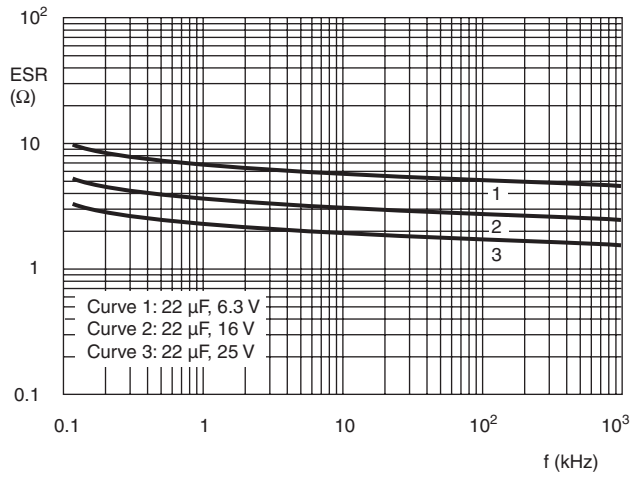


Fig.6 Typical ESR as a function of frequency at 20 °C

DISSIPATION FACTOR (tan δ)

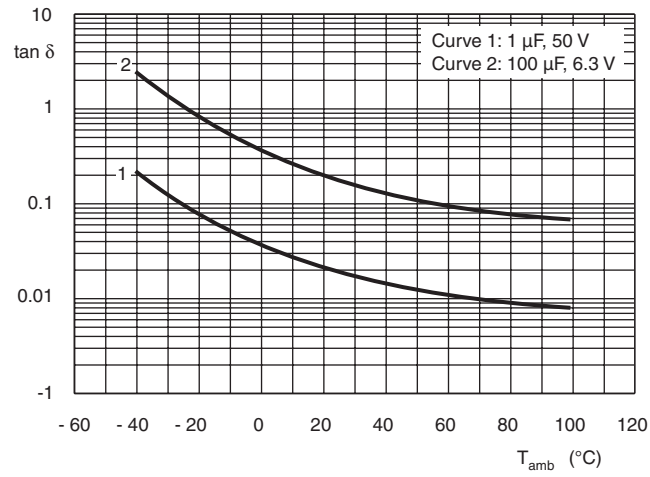


Fig.7 Typical dissipation factor (tan δ) at 100 Hz or 120 Hz as a function of ambient temperature

IMPEDANCE (Z)

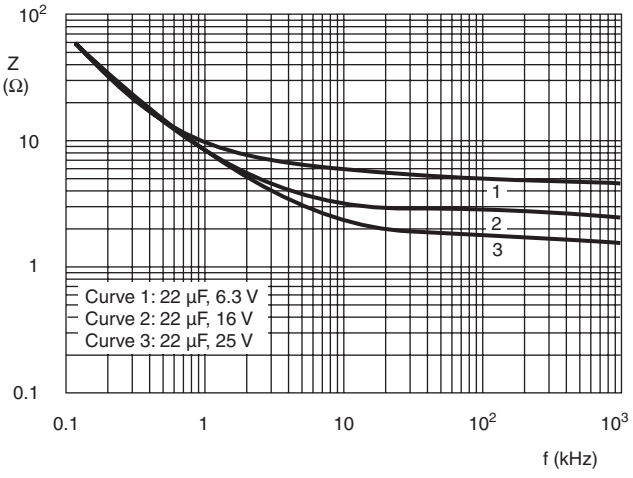
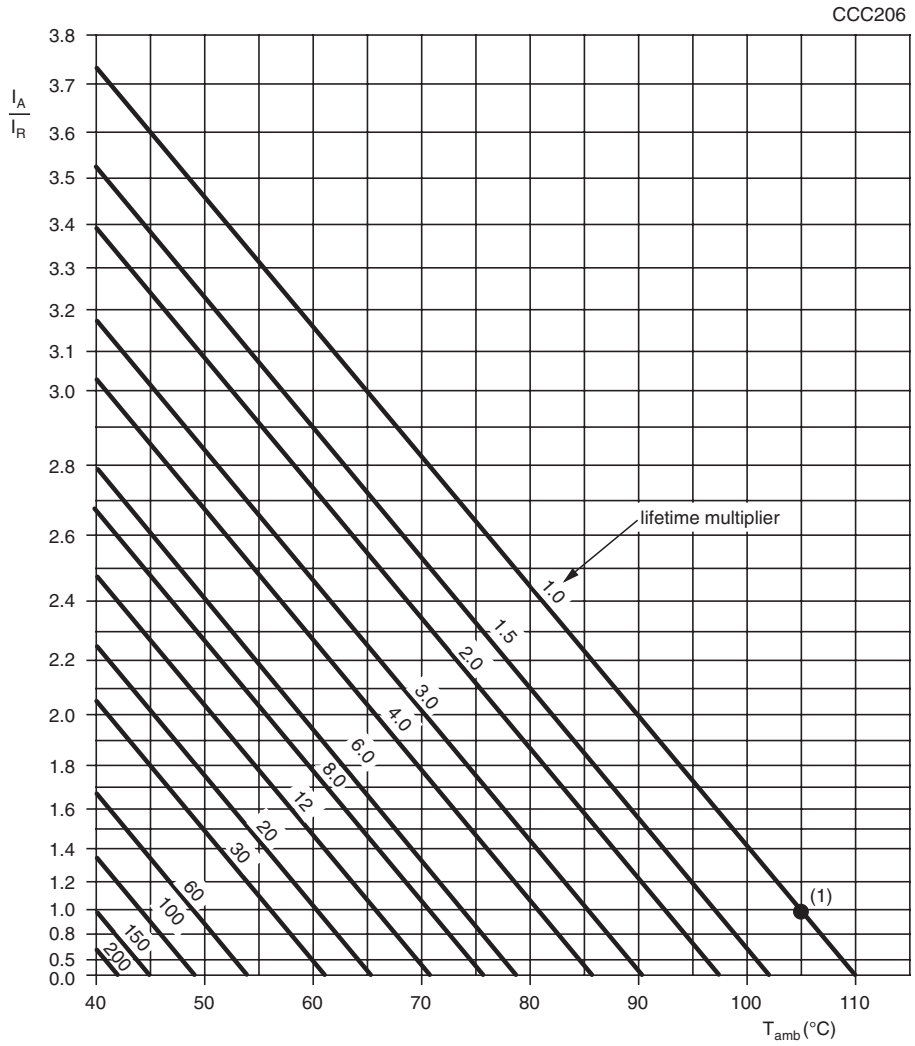


Fig.8 Typical impedance as a function of frequency at 20 °C

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz or 120 Hz
I_R = rated ripple current at 100 Hz or 120 Hz at 105 °C
For case codes 0405 to 1010 max. I_A/I_R = 2.4
(1) Useful life at 105 °C and I_R applied:
case codes 0405 to 0605: 2000 h
case codes 0807 to 1014: 3000 h

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 16 V	U_R = 25 or 35 V	U_R = 50 V to 100 V
50 or 60	0.80	0.80	0.80
100 or 120	1.00	1.00	1.00
300	1.10	1.15	1.20
1000	1.15	1.25	1.35
3000	1.20	1.35	1.45
≥ 10 000	1.25	1.40	1.50

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Mounting	IEC 60384-18, subclause 4.3	shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to chapter “Mounting”	ΔC/C: ± 10 % tan δ ≤ spec. limit I_{L2} ≤ spec. limit
Endurance	IEC 60384-18/ CECC 32300, subclause 4.15	T_{amb} = 105 °C; U_R applied; 1000 hours, case codes 0405 to 0605 2000 hours, case codes 0807 to 1014	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 2000 hours, case codes 0405 to 0605 3000 hours, case codes 0807 to 1014	ΔC/C: ± 50 % tan δ ≤ 3 x spec. limit I_{L2} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-18/ CECC 32 300, subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	for requirements see ‘Endurance test’ above

Aluminum Capacitors
SMD (Chip), Very Low Z

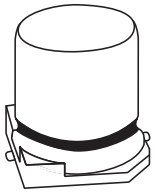
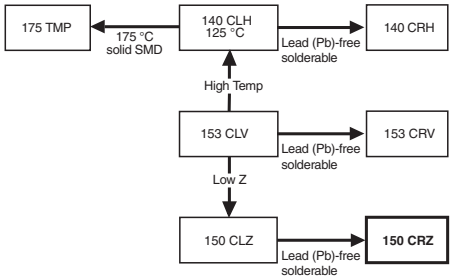


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing
- SMD-version with base plate, lead (Pb)-free reflow solderable
- Very low impedance, very high ripple current
- Very long useful life: 5000 hours at 105 °C for case size ≥ 12.5 x 12.5 x 13
- Standard 4 pin-version for diameter ≥ 12.5 mm
- 4 pin-version for diameter 10 mm on request
- Charge and discharge proof, no peak current limitation
- Lead (Pb)-free and RoHS compliant
- ATTENTION: for maximum safe soldering conditions refer to Fig. 4

Pb-free

RoHS COMPLIANT

APPLICATIONS

- SMD technology, for high mounting density
- Industrial and professional applications
- Automotive, general industrial
- Smoothing, filtering, buffering
- 4 pin-version for high vibration

MARKING

- Rated capacitance (in µF)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Black mark or '-' sign indicating the cathode (the anode is identified by bevelled edges)
- Code indicating group number (Z)

PACKAGING

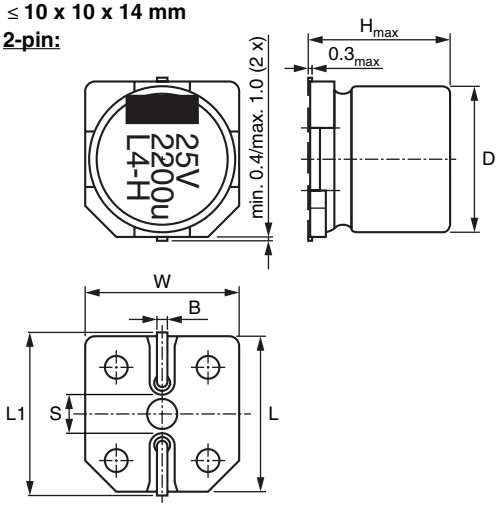
Supplied in blister tape on reel

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (L x W x H in mm)	8 x 8 x 10 to 12.5 x 12.5 x 16
Rated capacitance range, C_R	33 to 2200 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	- 55 to + 105 °C
Endurance test at 105 °C: case size ≤ 10 x 10 x 14 case size ≥ 12.5 x 12.5 x 13	 2000 hours 3000 hours
Useful life at 105 °C: case size ≤ 10 x 10 x 10 case size 10 x 10 x 14 case size ≥ 12.5 x 12.5 x 13	 2500 hours 3000 hours 5000 hours
Useful life at 40 °C; 1.8 x I_R applied: case size ≤ 10 x 10 x 10 case size 10 x 10 x 14 case size ≥ 12.5 x 12.5 x 13	 125 000 hours 150 000 hours 250 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-18/CECC32300
Climatic category IEC 60068	55/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm)

C_R (µF)	U_R (V)						
	6.3	**10**	**16**	**25**	**35**	**50**	**63**
33	-	-	-	-	-	-	8 x 8 x 10
47	-	-	-	-	-	-	8 x 8 x 10
	-	-	-	-	-	-	10 x 10 x 10
68	-	-	-	-	-	8 x 8 x 10	10 x 10 x 10
100	-	-	-	-	8 x 8 x 10	10 x 10 x 10	10 x 10 x 14
150	-	-	-	8 x 8 x 10	-	-	12.5 x 12.5 x 13
220	-	-	8 x 8 x 10	8 x 8 x 10	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 16
330	-	8 x 8 x 10	8 x 8 x 10	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 13	-
470	8 x 8 x 10	8 x 8 x 10	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 13	-	-
680	-	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 13	12.5 x 12.5 x 16	-	-
1000	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 13	12.5 x 12.5 x 16	-	-	-
1500	-	12.5 x 12.5 x 13	12.5 x 12.5 x 16	-	-	-	-
2200	12.5 x 12.5 x 13	12.5 x 12.5 x 16	-	-	-	-	-

≤ **10 x 10 x 14 mm**
2-pin:



≥ **12.5 x 12.5 x 13 mm**
4-pin:

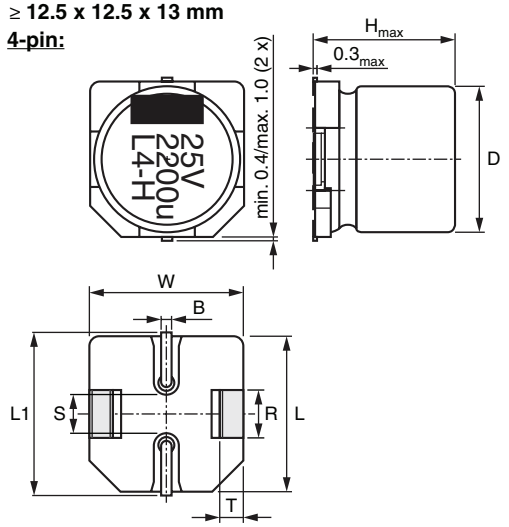


Fig.2 Dimensional Outline

Table 1

DIMENSIONS in millimeters **AND MASS**											
NOMINAL CASE SIZE L x W x H	**CASE CODE**	**$L_{max.}$**	**$W_{max.}$**	**$H_{max.}$**	**Ø D**	**$B_{max.}$**	**S**	**$L1_{max.}$**	**R ± 0.1**	**T ± 0.1**	**MASS (g)**
8 x 8 x 10	0810	8.5	8.5	10.5	8.0	1.0	2.2	9.9	-	-	≈ 1.0
10 x 10 x 10	1010	10.5	10.5	10.5	10.0	1.0	3.5	11.8	-	-	≈ 1.3
10 x 10 x 14	1014	10.5	10.5	14.3	10.0	1.0	3.5	11.8	-	-	≈ 1.5
12.5 x 12.5 x 13	1213	12.8	12.8	14.0	12.5	1.3	3.6	14.9	3.7	2.4	≈ 2.6
12.5 x 12.5 x 16	1216	12.8	12.8	16.5	12.5	1.3	3.6	14.9	3.7	2.4	≈ 2.8

Table 2

TAPE AND REEL DIMENSIONS in millimeters, **PACKAGING QUANTITIES**						
NOMINAL CASE SIZE L x W x H	**CASE CODE**	**PITCH P_1**	**TAPE WIDTH W**	**TAPE THICKNESS T_2**	**REEL DIAMETER**	**PACKAGING QUANTITY PER REEL**
8 x 8 x 10	0810	16	24	11.3	380	500
10 x 10 x 10	1010	16	24	11.3	380	500
10 x 10 x 14	1014	16	24	14.8	330	250
12.5 x 12.5 x 13	1213	20	24	15.5	380	250
12.5 x 12.5 x 16	1216	24	32	17.5	380	200

Note
Detailed tape dimensions see section 'PACKAGING'.

MOUNTING

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and/or adjacent components.

For recommended soldering pad dimensions, refer to Fig.3 and Table 3.

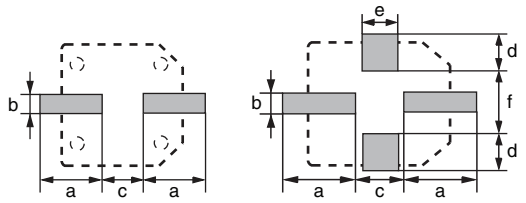
SOLDERING

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the component during processing.

For maximum conditions refer to Fig.4.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

AS A GENERAL PRINCIPLE, TEMPERATURE AND DURATION SHALL BE THE **MINIMUM** NECESSARY REQUIRED TO ENSURE GOOD SOLDERING CONNECTIONS. HOWEVER, THE SPECIFIED MAXIMUM CURVES SHOULD NEVER BE EXCEEDED.



Case size Ø D ≤ 10 mm Case size Ø D ≥ 12.5 mm

Fig.3 Recommended soldering pad dimensions

Table 3

RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters						
CASE CODE	**a**	**b**	**c**	**d**	**e**	**f**
0810	3.5	2.5	3.0	-	-	-
1010	4.3	2.5	4.0	-	-	-
1014	4.3	2.5	4.0	-	-	-
1213	5.5	2.5	4.0	4.2	5.0	5.6
1216	5.5	2.5	4.0	4.2	5.0	5.6

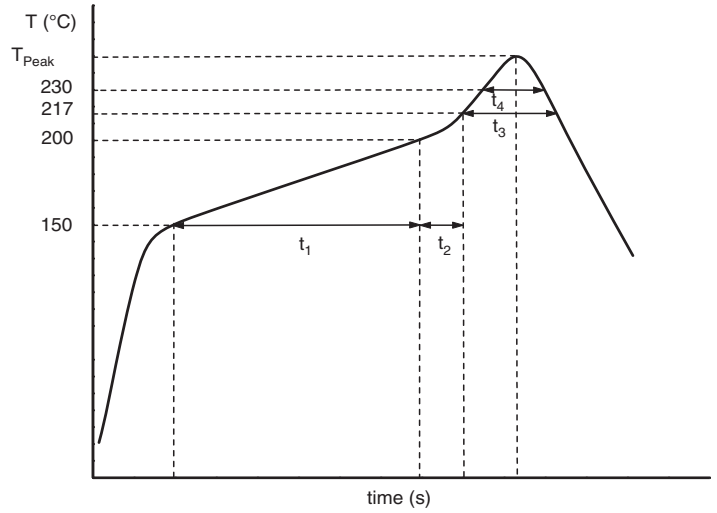


Fig.4 Maximum temperature load during reflow soldering

REFLOW SOLDERING CONDITIONS		
PROFILE FEATURES	**CASE CODE 0810 to 1014**	**CASE CODE 1213 to 1216**
Max. time from 25 °C to T_{peak}	240 s	200 s
Max. ramp-up rate to 150 °C	3 K/s	3 K/s
Max. time from 150 °C to 200 °C, (t_1)	150 s	120 s
Ramp up rate from 200 °C to T_{peak}	0.5 K/s to 3 K/s	0.5 K/s to 3 K/s
Max. time from 200 °C - 217 °C, (t_2)	60 s	60 s
Max. time above $T_{Liquidus}$ (217 °C) (t_3)	90 s	60 s
Max. time above 230 °C (t_4)	40 s	30 s
Peak temperature T_{peak}	250 °C	240 °C
Max. time above T_{peak} minus 5 °C	5 s	10 s
Max. ramp-down rate from $T_{Liquidus}$	6 K/s	6 K/s

Note

Temperature measuring point on top of the case and terminals max. 2 runs with pause of min. 30 minutes in between

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 kHz, 105 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 150 CRZ series

220 µF/50 V; ± 20 %

Nominal case size: 10 x 10 x 14 mm; taped on reel

Ordering Code: MAL215097102E3
Former 12 NC: 2222 150 97102

Table 4

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R (µF)	NOMINAL CASE SIZE L x W x H (mm)	I_R 105 °C 100 kHz (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz 20 °C (Ω)	Z 100 kHz - 40 °C (Ω)	ORDERING CODE MAL2150.....
6.3	470	8 x 8 x 10	435	30	0.24	0.250	2.000	97311E3
	1000	10 x 10 x 10	670	63	0.24	0.130	1.100	97301E3
	2200	12.5 x 12.5 x 13	905	139	0.26	0.077	0.600	97312E3
10	330	8 x 8 x 10	435	33	0.20	0.250	2.000	97411E3
	470	8 x 8 x 10	435	47	0.20	0.250	2.000	97412E3
	680	10 x 10 x 10	670	68	0.20	0.130	1.100	97401E3
	1000	10 x 10 x 14	850	100	0.20	0.100	0.800	97402E3
	1500	12.5 x 12.5 x 13	905	150	0.22	0.077	0.600	97413E3
	2200	12.5 x 12.5 x 16	1007	220	0.22	0.060	0.480	97414E3
16	220	8 x 8 x 10	435	35	0.16	0.250	2.000	97511E3
	330	8 x 8 x 10	435	53	0.16	0.250	2.000	97512E3
	470	10 x 10 x 10	670	75	0.16	0.130	1.100	97501E3
	680	10 x 10 x 14	850	109	0.16	0.100	0.800	97502E3
	1000	12.5 x 12.5 x 13	905	160	0.18	0.077	0.600	97513E3
	1500	12.5 x 12.5 x 16	1007	240	0.18	0.060	0.480	97514E3
25	150	8 x 8 x 10	420	38	0.14	0.280	2.240	97611E3
	220	8 x 8 x 10	420	55	0.14	0.280	2.240	97612E3
	330	10 x 10 x 10	640	83	0.14	0.140	1.120	97601E3
	470	10 x 10 x 14	820	118	0.14	0.110	0.880	97602E3
	680	12.5 x 12.5 x 13	905	170	0.16	0.077	0.600	97613E3
	1000	12.5 x 12.5 x 16	1007	250	0.16	0.060	0.480	97614E3
35	100	8 x 8 x 10	405	35	0.12	0.300	2.400	97011E3
	220	10 x 10 x 10	630	77	0.12	0.150	1.200	97001E3
	330	10 x 10 x 14	790	116	0.12	0.120	0.960	97002E3
	470	12.5 x 12.5 x 13	905	165	0.14	0.077	0.600	97012E3
	680	12.5 x 12.5 x 16	1007	238	0.14	0.060	0.480	97013E3
50	68	8 x 8 x 10	333	34	0.12	0.480	3.840	97111E3
	100	10 x 10 x 10	490	50	0.12	0.240	1.920	97101E3
	220	10 x 10 x 14	620	110	0.12	0.190	1.520	97102E3
	330	12.5 x 12.5 x 13	690	165	0.12	0.130	1.040	97112E3
63	33	8 x 8 x 10	270	21	0.10	0.650	5.200	97812E3
	47	8 x 8 x 10	270	30	0.10	0.650	5.200	97811E3
	47	10 x 10 x 10	390	30	0.10	0.380	3.000	97801E3
	68	10 x 10 x 10	390	43	0.10	0.380	3.000	97802E3
	100	10 x 10 x 14	507	63	0.10	0.290	2.320	97803E3
	150	12.5 x 12.5 x 13	507	97	0.10	0.250	2.000	97821E3
	220	12.5 x 12.5 x 16	637	141	0.10	0.200	1.600	97815E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage for short periods	IEC 60384-18, subclause 4.14	$U_s \leq 1.15 \times U_R$
Reverse voltage for short periods	IEC 60384-18, subclause 4.16	$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$
Inductance		
Equivalent series inductance (ESL)	Ø D = 8 mm	typ. 6 nH
	Ø D = 10 mm	typ. 8 nH
	Ø D ≥ 12.5 mm	typ. 11 nH
Resistance		
Equivalent series resistance (ESR) at 100 Hz	Calculated from tan $\delta_{max.}$ and C_R (see Table 4)	ESR = tan $\delta/2\,\pi\,f\,C_R$

CAPACITANCE

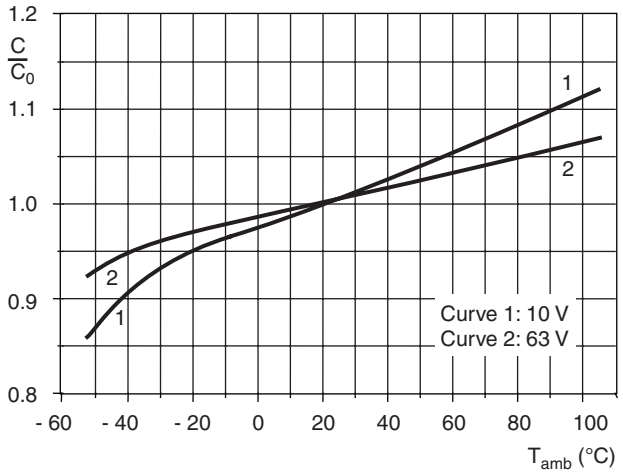


Fig.5 Typical multiplier of capacitance C as a function of temperature at 100 Hz
C_0 = typical capacitance C at 20 °C, 100 Hz

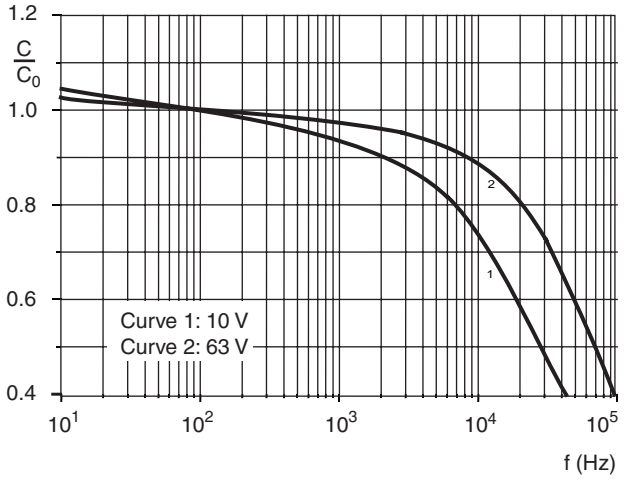


Fig.6 Typical multiplier of capacitance as a function of frequency at 20 °C
C_0 = typical capacitance at 20 °C, 100 Hz

EQUIVALENT SERIES RESISTANCE (ESR)

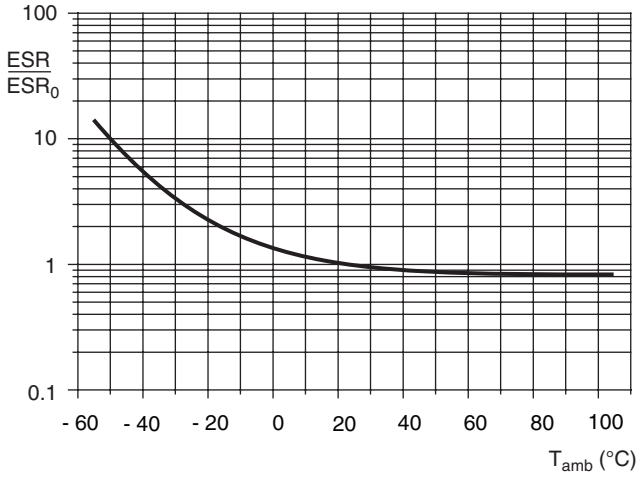


Fig.7 Typical multiplier of ESR as a function of temperature at 100 Hz
ESR_0 = typical ESR at 20 °C, 100 Hz

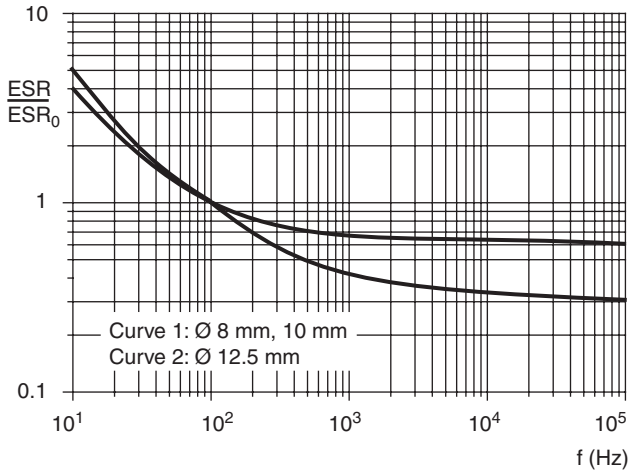


Fig.8 Typical multiplier ESR as a function of frequency at 20 °C
ESR_0 = typical ESR at 20 °C, 100 Hz

DISSIPATION FACTOR (tan δ)

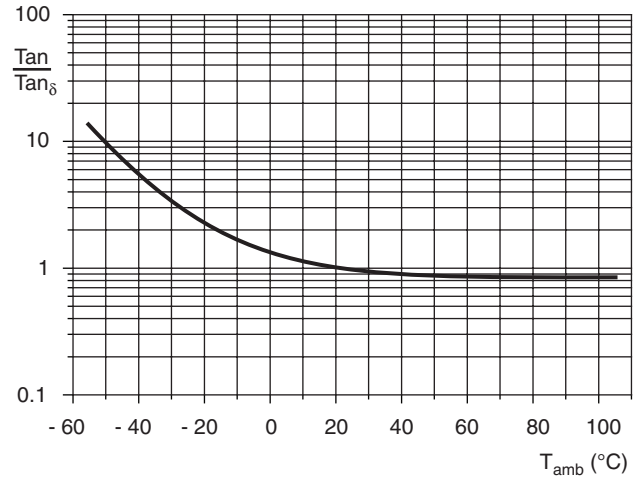


Fig.9 Typical multiplier of dissipation factor tan $_\delta$ as a function of temperature at °C 20 at 100 Hz
tan δ_0 = typical tan δ at 20 °C, 100 Hz

IMPEDANCE (Z)

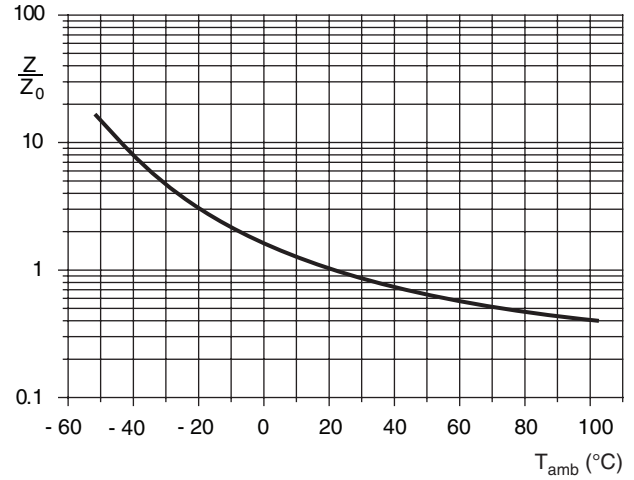


Fig.10 Typical multiplier of impedance Z as a function of temperature at 100 kHz
Z_0 = typical impedance Z at 20 °C, 100 kHz

IMPEDANCE (Z)

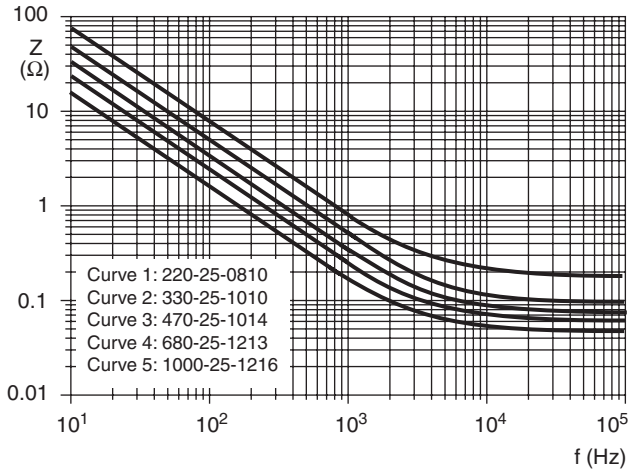


Fig.11 Typical impedance Z as a function of frequency at 20 °C

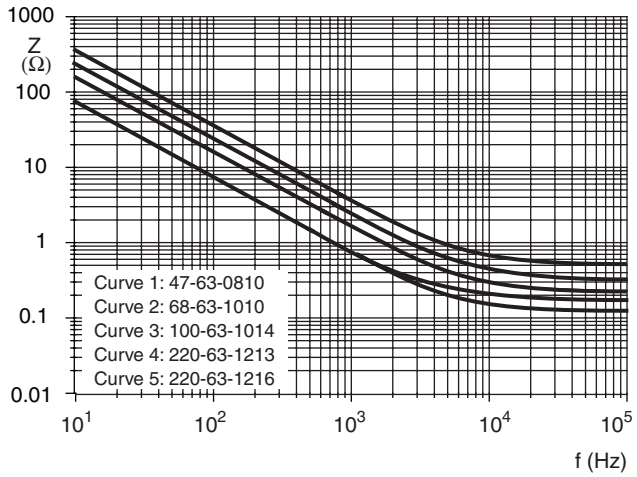
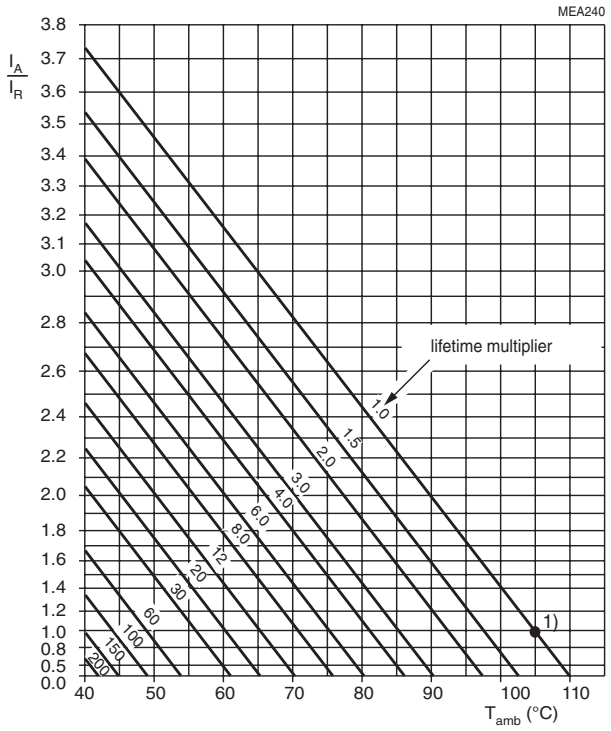


Fig.12 Typical impedance Z as a function of frequency at 20 °C

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C
(1) = useful life at 105 °C and I_R applied: 2000 h

Fig.10 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 V	U_R = 50 to 63 V
100	0.70	0.65	0.60
300	0.80	0.80	0.75
1000	0.85	0.85	0.85
3000	0.93	0.93	0.93
10 000	0.95	0.95	0.95
30 000	0.97	0.97	0.97
100 000	1.00	1.00	1.00

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Mounting	IEC 60384-18, subclause 4.3	shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to chapter “Mounting”	$\Delta C/C$: ± 5 % tan $\delta \leq$ spec. limit $I_{L2} \leq$ spec. limit
Endurance	IEC 60384-18/ CECC32300, subclause 4.15	T_{amb} = 105 °C; U_R applied; case size ≤ 10 x 10 x 14: 2000 hours case size ≥ 12.5 x 12.5 x 13: 3000 hours	U_R = 6.3 V; $\Delta C/C$: ± 25 % $U_R \geq$ 10 V; $\Delta C/C$: ± 20 % tan $\delta \leq$ 2 x spec. limit $I_{L2} \leq$ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; case size ≤ 10 x 10 x 10: 2500 hours case size = 10 x 10 x 14: 3000 hours case size ≥ 12.5 x 12.5 x 13: 5000 hours	$\Delta C/C$: ± 30 % tan $\delta \leq$ 3 x spec. limit $I_{L2} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-18/ CECC32300, subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	for requirements see ‘Endurance test’ above

Aluminum Capacitors
SMD (Chip), High Temperature

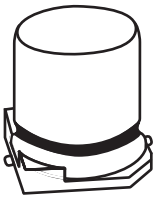
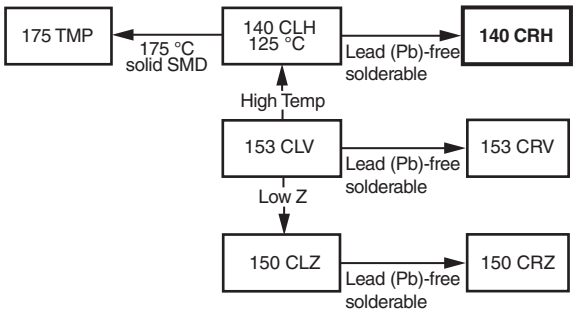


Fig.1 Component outline



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (L x W x H in mm)	8 x 8 x 10 to 12.5 x 12.5 x 16
Rated capacitance range, C_R	10 to 1000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	- 55 to + 125 °C
Endurance test at 125 °C: case size ≤ 10 x 10 x 14 case size ≥ 12.5 x 12.5 x 13	 1000 hours 2000 hours
Useful life at 125 °C: case size ≤ 10 x 10 x 14 case size ≥ 12.5 x 12.5 x 13	 1500 hours 3000 hours
Useful life at 40 °C; 1.8 x I_R applied: case size ≤ 10 x 10 x 14 case size ≥ 12.5 x 12.5 x 13	 150 000 hours 300 000 hours
Shelf life at 0 V, 125 °C	1000 hours
Based on sectional specification	IEC 60384-18/CECC32300
Climatic category IEC 60068	55/125/56

FEATURES

Pb-free

RoHS COMPLIANT

- Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing
- SMD-version with base plate, lead (Pb)-free reflow solderable
- High temperature, 3000 h at 125 °C
- High capacitance values
- Very long useful life: 5000 h at 105 °C for case size ≥ 12.5 x 12.5 x 13
- Standard 4 pin-version for diameter ≥ 12.5 mm
- 4 pin-version for diameter 10 mm on request
- Charge and discharge proof, no peak current limitation
- Lead (Pb)-free and RoHS compliant
- ATTENTION: for maximum safe soldering conditions refer to Fig. 4

APPLICATIONS

- SMD technology, for high mounting density
- Industrial and professional applications
- Automotive, general industrial
- Smoothing, filtering, buffering
- 4 pin-version for high vibration

MARKING

- Rated capacitance (in µF)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Black mark or '-' sign indicating the cathode (the anode is identified by bevelled edges)
- Code indicating group number (H)

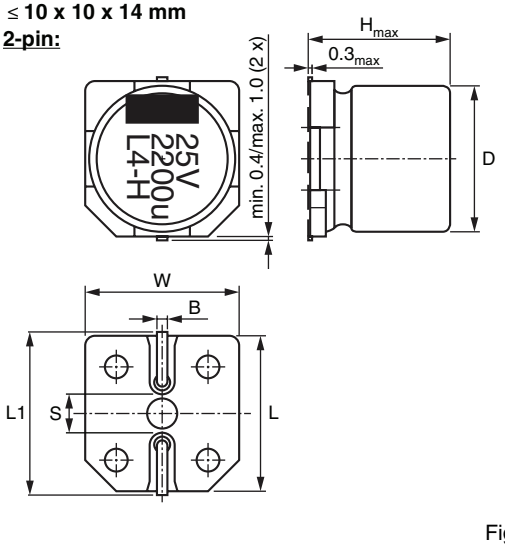
PACKAGING

Supplied in blister tape on reel

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm)

C_R (µF)	U_R (V)						
	6.3	10	16	25	35	50	63
10	-	-	-	-	-	-	8 x 8 x 10
22	-	-	-	-	-	-	8 x 8 x 10
33	-	-	-	-	-	-	8 x 8 x 10
47	-	-	-	-	-	8 x 8 x 10	10 x 10 x 10
68	-	-	-	-	8 x 8 x 10	10 x 10 x 10	10 x 10 x 14
100	-	-	-	8 x 8 x 10	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 13
150	-	-	8 x 8 x 10	-	10 x 10 x 14	-	12.5 x 12.5 x 16
220	-	8 x 8 x 10	-	10 x 10 x 10	12.5 x 12.5 x 13	12.5 x 12.5 x 13	-
330	8 x 8 x 10	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 13	12.5 x 12.5 x 13	12.5 x 12.5 x 16	-
470	10 x 10 x 10	10 x 10 x 14	12.5 x 12.5 x 13	12.5 x 12.5 x 16	12.5 x 12.5 x 16	-	-
680	10 x 10 x 14	12.5 x 12.5 x 13	12.5 x 12.5 x 16	-	-	-	-
1000	-	12.5 x 12.5 x 16	-	-	-	-	-

≤ 10 x 10 x 14 mm
2-pin:



≥ 12.5 x 12.5 x 13 mm
4-pin:

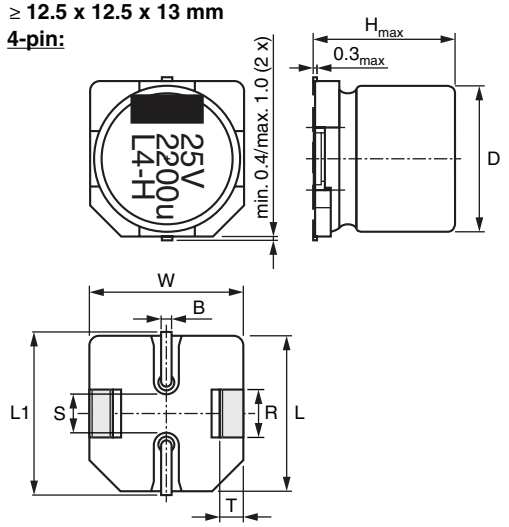


Fig.2 Dimensional outline

Table 1

DIMENSIONS in millimeters **AND MASS**											
NOMINAL CASE SIZE L x W x H	**CASE CODE**	**$L_{max.}$**	**$W_{max.}$**	**$H_{max.}$**	**Ø D**	**$B_{max.}$**	**S**	**$L1_{max.}$**	**R ± 0.1**	**T ± 0.1**	**MASS (g)**
8 x 8 x 10	0810	8.5	8.5	10.5	8.0	1.0	2.2	9.9	-	-	≈ 1.0
10 x 10 x 10	1010	10.5	10.5	10.5	10.0	1.0	3.5	11.8	-	-	≈ 1.3
10 x 10 x 14	1014	10.5	10.5	14.3	10.0	1.0	3.5	11.8	-	-	≈ 1.5
12.5 x 12.5 x 13	1213	12.8	12.8	14.0	12.5	1.3	3.6	14.9	3.7	2.4	≈ 2.6
12.5 x 12.5 x 16	1216	12.8	12.8	16.5	12.5	1.3	3.6	14.9	3.7	2.4	≈ 2.8

Table 2

TAPE AND REEL DIMENSIONS in millimeters, **PACKAGING QUANTITIES**						
NOMINAL CASE SIZE L x W x H	**CASE CODE**	**PITCH P_1**	**TAPE WIDTH W**	**TAPE THICKNESS T_2**	**REEL DIAMETER**	**PACKAGING QUANTITY PER REEL**
8 x 8 x 10	0810	16	24	11.3	380	500
10 x 10 x 10	1010	16	24	11.3	380	500
10 x 10 x 14	1014	16	24	14.8	330	250
12.5 x 12.5 x 13	1213	20	24	15.5	380	250
12.5 x 12.5 x 16	1216	24	32	17.5	380	200

Note
Detailed tape dimensions see section 'PACKAGING'.

MOUNTING

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and/or adjacent components.

For recommended soldering pad dimensions, refer to Fig.3 and Table 3.

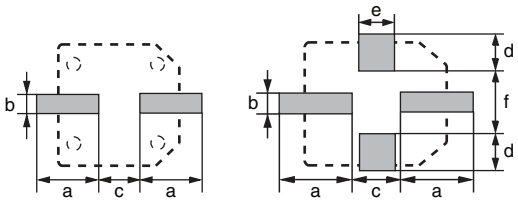
SOLDERING

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the component during processing.

For maximum conditions refer to Fig.4.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

AS A GENERAL PRINCIPLE, TEMPERATURE AND DURATION SHALL BE THE **MINIMUM** NECESSARY REQUIRED TO ENSURE GOOD SOLDERING CONNECTIONS. HOWEVER, THE SPECIFIED MAXIMUM CURVES SHOULD NEVER BE EXCEEDED.



Case size Ø D ≤ 10 mm Case size Ø D ≥ 12.5 mm

Fig.3 Recommended soldering pad dimensions

Table 3

RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters						
CASE CODE	**a**	**b**	**c**	**d**	**e**	**f**
0810	3.5	2.5	3.0	-	-	-
1010	4.3	2.5	4.0	-	-	-
1014	4.3	2.5	4.0	-	-	-
1213	5.5	2.5	4.0	4.2	5.0	5.6
1216	5.5	2.5	4.0	4.2	5.0	5.6

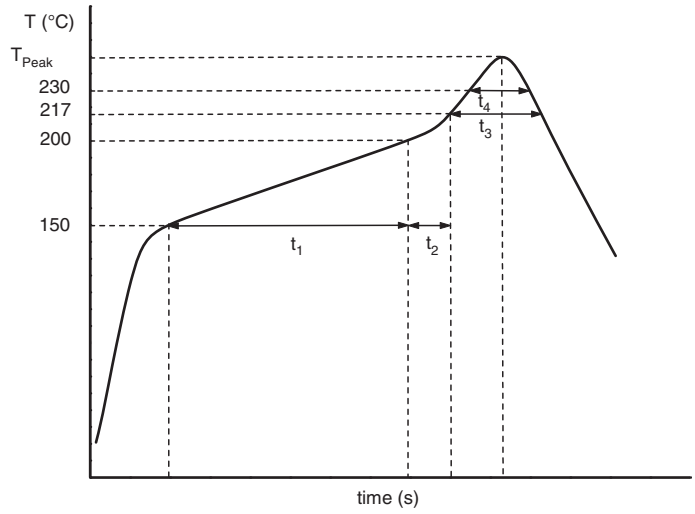


Fig.4 Maximum temperature load during reflow soldering

REFLOW SOLDERING CONDITIONS		
PROFILE FEATURES	**CASE CODE 0810 to 1014**	**CASE CODE 1213 to 1216**
Max. time from 25 °C to T_{Peak}	240 s	200 s
Max. ramp-up rate to 150 °C	3 K/s	3 K/s
Max. time from 150 °C to 200 °C, (t_1)	150 s	120 s
Ramp up rate from 200 °C to T_{Peak}	0.5 K/s to 3 K/s	0.5 K/s to 3 K/s
Max. time from 200 °C to 217 °C, (t_2)	60 s	60 s
Max. time above $T_{Liquidus}$ (217 °C) (t_3)	90 s	60 s
Max. time above 230 °C (t_4)	40 s	30 s
Peak temperature T_{Peak}	250 °C	240 °C
Max. time above T_{Peak} minus 5 °C	5 s	10 s
Max. ramp-down rate from $T_{Liquidus}$	6 K/s	6 K/s

Note

Temperature measuring point on top of the case and terminals max. 2 runs with pause of min. 30 min in between

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 kHz, 125 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 140 CRH series

100 µF/50 V; ± 20 %

Nominal case size: 10 x 10 x 14 mm; taped on reel

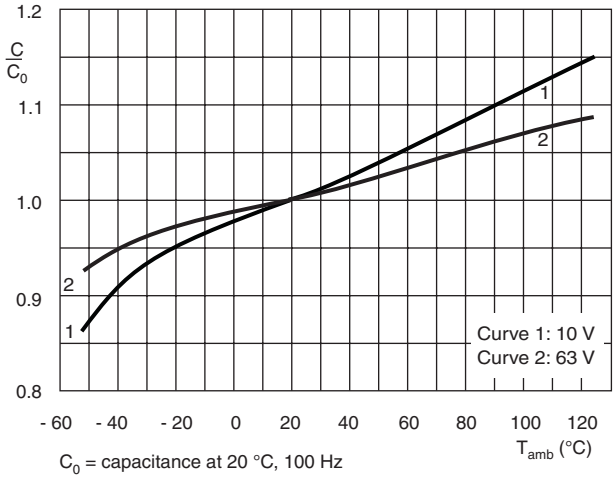
Ordering Code: MAL214097102E3
Former 12NC: 2222 140 97102

Table 4

ELECTRICAL DATA AND ORDERING INFORMATION							
U_R (V)	C_R (µF)	NOMINAL CASE SIZE L x W x H (mm)	I_R 100 kHz 125 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz 20 °C (Ω)	ORDERING CODE MAL2140.....
6.3	330	8 x 8 x 10	180	21	0.30	0.40	97303E3
	470	10 x 10 x 10	300	30	0.30	0.25	97301E3
	680	10 x 10 x 14	430	43	0.30	0.12	97302E3
10	220	8 x 8 x 10	180	22	0.26	0.40	97403E3
	330	10 x 10 x 10	300	33	0.26	0.25	97401E3
	470	10 x 10 x 14	430	47	0.26	0.12	97402E3
	680	12.5 x 12.5 x13	750	68	0.22	0.12	97411E3
	1000	12.5 x 12.5 x 16	900	100	0.22	0.09	97412E3
16	150	8 x 8 x 10	180	24	0.22	0.40	97502E3
	330	10 x 10 x 14	430	53	0.22	0.20	97501E3
	470	12.5 x 12.5 x 13	750	75	0.18	0.12	97511E3
	680	12.5 x 12.5 x 16	900	108	0.18	0.09	97512E3
25	100	8 x 8 x 10	180	25	0.18	0.40	97602E3
	220	10 x 10 x 10	300	55	0.18	0.25	97601E3
	330	12.5 x 12.5 x 13	750	82	0.16	0.12	97611E3
	470	12.5 x 12.5 x 16	900	117	0.16	0.09	97612E3
35	68	8 x 8 x 10	180	24	0.14	0.40	97003E3
	100	10 x 10 x 10	255	35	0.14	0.25	97001E3
	150	10 x 10 x 14	317	53	0.14	0.20	97002E3
	220	12.5 x 12.5 x 13	750	77	0.14	0.12	97011E3
	330	12.5 x 12.5 x 13	750	115	0.14	0.12	97012E3
	470	12.5 x 12.5 x 16	900	164	0.14	0.09	97013E3
50	47	8 x 8 x 10	145	24	0.14	0.70	97103E3
	68	10 x 10 x 10	205	34	0.14	0.50	97101E3
	100	10 x 10 x 14	255	50	0.14	0.40	97102E3
	220	12.5 x 12.5 x 13	750	110	0.12	0.23	97111E3
	330	12.5 x 12.5 x 16	900	165	0.12	0.18	97112E3
63	10	8 x 8 x 10	145	6.3	0.12	0.70	97805E3
	22	8 x 8 x 10	145	14	0.12	0.70	97803E3
	33	8 x 8 x 10	145	21	0.12	0.70	97804E3
	47	10 x 10 x 10	205	30	0.12	0.50	97801E3
	68	10 x 10 x 14	255	43	0.12	0.40	97802E3
	100	12.5 x 12.5 x 13	500	63	0.14	0.25	97811E3
	220	12.5 x 12.5 x 16	600	138	0.14	0.20	97812E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage for short periods	IEC 60384-18, subclause 4.14	$Us \leq 1.15 \times U_R$
Reverse voltage for short periods	IEC 60384-18, subclause 4.16	$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$IL2 \leq 0.0 \times C_R \times U_R$
Inductance		
Equivalent series inductance (ESL)	Ø D = 8 mm	typ. 6 nH
	Ø D = 10 mm	typ. 8 nH
	Ø D ≥ 12.5 mm	typ. 11 nH
Resistance		
Equivalent series resistance (ESR) at 100 Hz	Calculated from tan $\delta_{max.}$ and C_R (see Table 4)	ESR = tan $\delta/2 \pi f C_R$

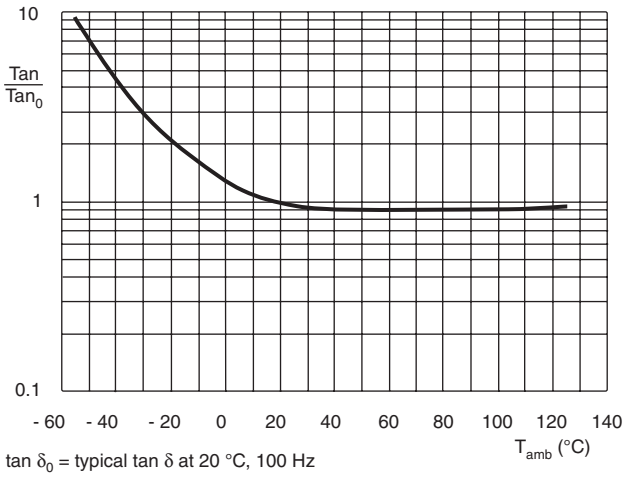
CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100 Hz

Fig.5 Typical multiplier of capacitance as function of ambient temperature

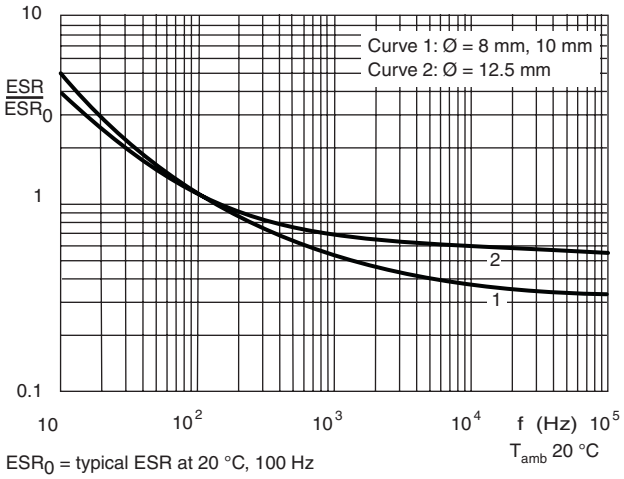
DISSIPATION FACTOR (tan δ)



tan δ_0 = typical tan δ at 20 °C, 100 Hz

Fig.6 Multiplier of dissipation factor (tan δ) as function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)



ESR_0 = typical ESR at 20 °C, 100 Hz

Fig.7 Typical multiplier of ESR as function of frequency

IMPEDANCE (ESR)

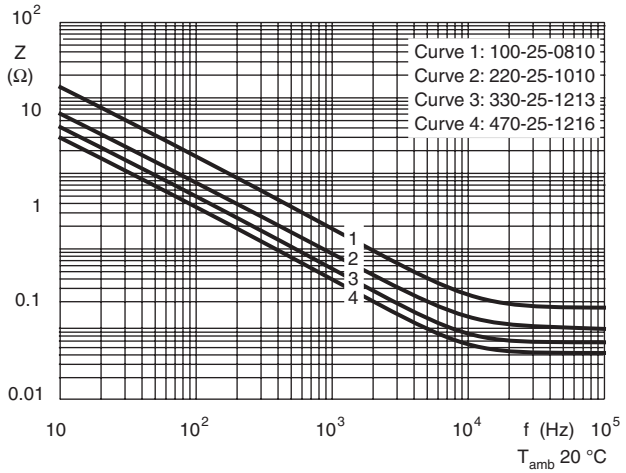


Fig.8 Typical impedance as function of frequency

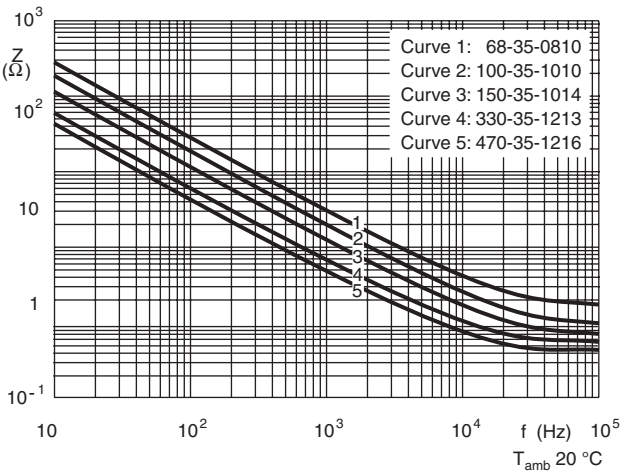


Fig.9 Typical impedance as function of frequency

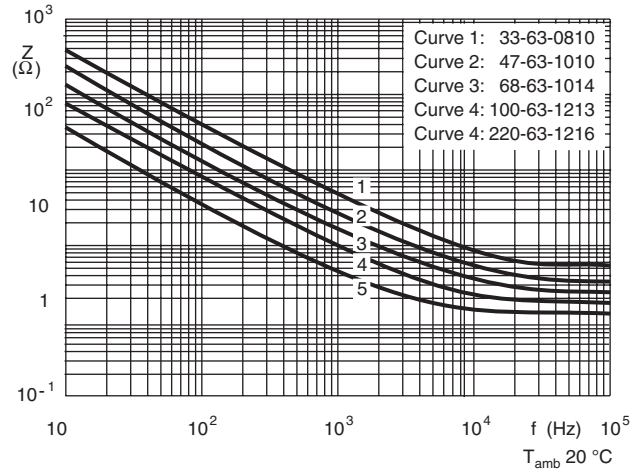
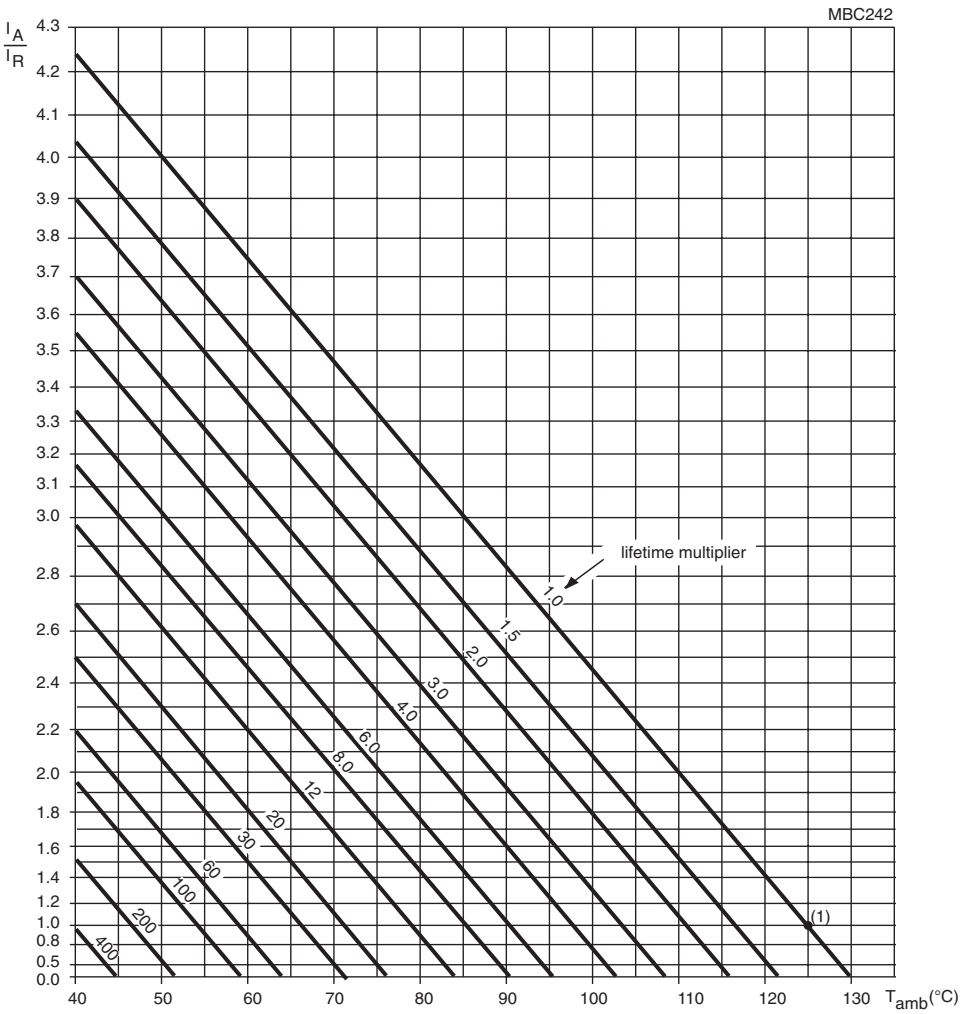


Fig.10 Typical impedance as function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 kHz

I_R = rated ripple current at 100 kHz, 125 °C

(1) Useful life at 125 °C and I_R applied:
case code ≤ 1014: 1500 h
case code ≥ 1014: 3000 h

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 and 50 V	U_R = 63 V
50	0.60	0.45	0.40
100	0.70	0.60	0.55
300	0.80	0.75	0.70
1000	0.85	0.85	0.85
3000	0.90	0.90	0.90
10 000	0.95	0.95	0.95
30 000	0.97	0.97	0.97
100 000	1.00	1.00	1.00

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Mounting	IEC 60384-18, subclause 4.3	shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to chapter “Mounting”	$\Delta C/C$: ± 5 % tan $\delta \leq$ spec. limit $I_{L2} \leq$ spec. limit
Endurance	IEC 60384-18/ CECC 32 300, subclause 4.15	T_{amb} = 125 °C; U_R applied; case size ≤ 10 x 10 x 14: 1000 h case size ≥ 12.5 x 12.5 x 13: 2000 h	U_R = 6.3 V; $\Delta C/C$: ± 25 % $U_R \geq$ 10 V; $\Delta C/C$: ± 20 % tan $\delta \leq$ 2 x spec. limit $I_{L2} \leq$ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; case size ≤ 10 x 10 x 14: 1500 h case size ≥ 12.5 x 12.5 x 13: 3000 h	$\Delta C/C$: ± 50 % tan $\delta \leq$ 3 x spec. limit $I_{L2} \leq$ spec. limit no short or open circuit’ total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-18/ CECC 32 300, subclause 4.17	T_{amb} = 125 °C; no voltage applied; 1000 h after test: U_R to be applied for 30 min, 24 to 48 h before measurement	for requirements see ‘Endurance test’ above
Reverse voltage	IEC 60384-18/ CECC 32 300, subclause 4.16	T_{amb} = 125 °C: 125 h at U = - 0.5 V, followed by 125 h at U_R	$\Delta C/C$: ± 15 % tan $\delta \leq$ 1.5 x spec. limit $I_{L2} \leq$ spec. limit

Aluminum Capacitors
High Temperature Solid Electrolytic SMD

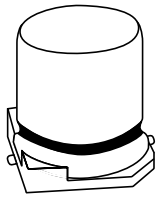
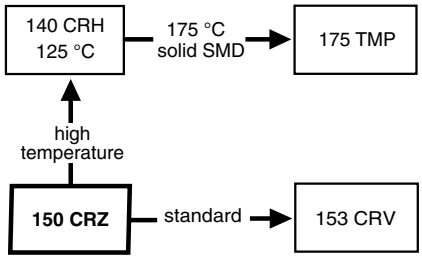


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors SMD, solid electrolyte MnO_2
- Extremely long useful life, 20 000 h/125 °C
- High temperature, usable up to 175 °C
- Excellent impedance and ESR behavior, at low and high temperature
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.5 x U_R allowed
- AC voltage up to 0.8 x U_R allowed
- High shock and vibration capability
- High ripple current per volume in SMD

Pb-free

RoHS
COMPLIANT

APPLICATIONS

- SMD technology
- Smoothing, filtering, buffering
- Telecommunications, professional industrial, EDP, high end power conversion, automotive
- Power supplies, SMPS for telecommunications

PACKAGING

Supplied in blister tape on reel.

MARKING

- Rated capacitance (in µF)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Black mark or '-' sign indicating the cathode (the anode is identified by bevelled edges)
- Code indicating group number (V) HT

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (L x W x H in mm)	8 x 8 x 10
Rated capacitance range, C_R	1 to 68 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	4 to 40 V
Rated temperature range	- 55 to + 85 °C
Category temperature range: U_{C1} = 4 to 25 V U_{C2} = 4 to 16 V	 - 55 to + 125 °C - 55 to + 175 °C
Endurance test at 175 °C	1000 hours
Endurance test at 125 °C	10 000 hours
Useful life at 175 °C	2000 hours
Useful life at 125 °C	20 000 hours
Useful life at 40 °C, I_R applied	> 300 000 hours
Shelf life at 0 V, 125 °C	500 h
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/175/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES

C_R (µF)	U_R (V) at T_{amb} = 85 °C						
	4	6.3	10	16	20	25	40
	U_{C1} (V) at T_{amb} = 125 °C						
	4	6.3	10	16	20	25	25
	U_{C2} (V) at T_{amb} = 175 °C						
	4	6.3	10	16	16	16	16
1	-	-	-	-	-	-	0810
2.2	-	-	-	-	-	-	0810
3.3	-	-	-	-	-	0810	-
4.7	-	-	-	-	-	0810	-
6.8	-	-	-	-	0810	0810	-
10	-	-	-	0810	-	0810	-
15	-	-	0810	-	-	-	-
22	-	-	0810	-	-	-	-
33	-	0810	-	-	-	-	-
47	-	0810	-	-	-	-	-
68	0810	-	-	-	-	-	-

Table 1

TAPE AND REEL DIMENSIONS in millimeters					
CASE CODE	**PITCH P_1**	**TAPE WIDTH W**	**TAPE THICKNESS T_2**	**REEL DIA.**	**PACKAGING QUANTITY PER REEL**
0810	16	24	11	380	500

Table 2

DIMENSIONS in millimeters **AND MASS** (see Fig.2)									
NOMINAL CASE SIZE L x W x H	**CASE CODE**	**$L_{max.}$**	**$W_{max.}$**	**$H_{max.}$**	**Ø D**	**$B_{max.}$**	**S**	**C**	**MASS (g)**
8.0 x 8.0 x 10.0	0810	8.4	8.4	10.7	8.0	1	4.7	2.2 ± 0.2	≈ 0.8

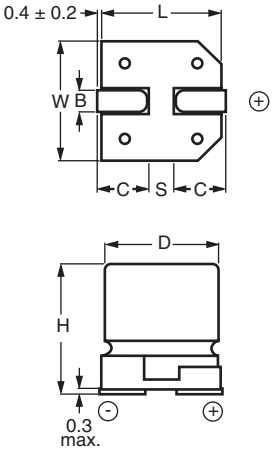


Fig.2 Dimensional outline

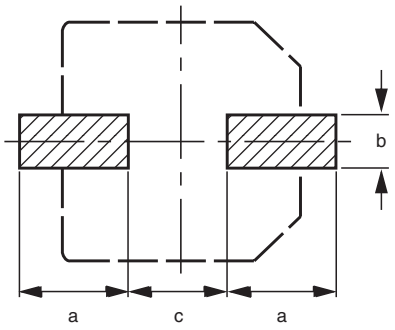


Fig.3 Recommended soldering pad dimensions

AS A GENERAL PRINCIPLE, TEMPERATURE AND DURATION SHALL BE THE **MINIMUM** NECESSARY REQUIRED TO ENSURE GOOD SOLDERING CONNECTIONS.

MOUNTING

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and/or adjacent components.

For recommended soldering pad dimensions, refer to Fig.3 and Table 3.

SOLDERING

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the soldering pad during processing.

Resistant against 260 °C reflow temperature; see Fig.4. Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

Table 3

RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters			
CASE CODE	**a**	**b**	**c**
0810	3.0	2.5	4.0

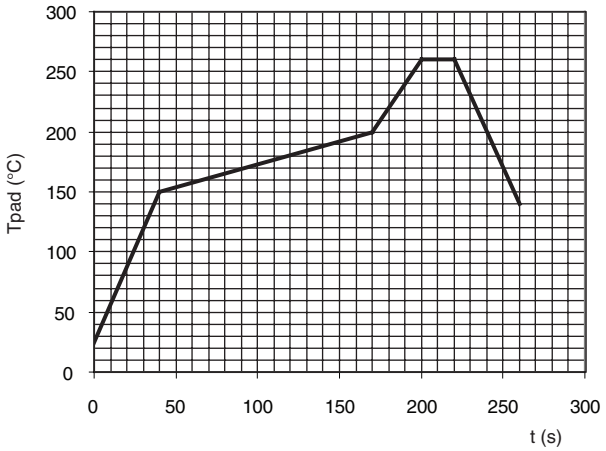


Fig.4 Maximum temperature load during infrared reflow soldering measured on the soldering pad

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	typical RMS ripple current no necessary DC voltage applied
I_{L5}	typical leakage current after 5 minutes at U_R
ESR	typical equivalent series resistance at 100 kHz
$Z_{F\ RES}$	typical impedance at average resonance frequency

Note

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 175 TMP series

47 µF/6.3 V; ± 20 %

Nominal case size: 8 x 8 x 10 mm; taped on reel

Lead (Pb)-free terminations

Ordering code: MAL2 175 73479 E3

Former 12NC: 2222 175 73479

Table 4

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	U_{C1} 125 °C (V)	U_C2 175 °C (V)	C_R (µF)	NOMINAL CASE SIZE L x W x H (mm)	I_R 100 kHz 175 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (mA)	TYP. ESR 100 kHz (Ω)	TYP. $Z_{F\ RES}$ (Ω)	TYP. $Z_{F\ RES}$ (MHz)	ORDERING CODE MAL2175.....
4	4	4	68	8.0 x 8.0 x 10.0	426	2660	5	0.15	0.11	0.65	72689E3
6.3	6.3	6.3	33	8.0 x 8.0 x 10.0	426	2660	4	0.15	0.1	0.71	73339E3
			47	8.0 x 8.0 x 10.0	413	2580	5	0.16	0.11	0.73	73479E3
10	10	10	15	8.0 x 8.0 x 10.0	234	1460	3	0.5	0.25	2.0	74159E3
			22	8.0 x 8.0 x 10.0	301	1880	3	0.31	0.22	2.0	74229E3
16	16	16	10	8.0 x 8.0 x 10.0	186	1160	3	0.79	0.38	3.2	75109E3
20	20	16	6.8	8.0 x 8.0 x 10.0	142	890	2	1.31	0.69	5.1	78688E3
25	25	16	3.3	8.0 x 8.0 x 10.0	91	653	2	2.0	0.7	7.7	76338E3
			4.7	8.0 x 8.0 x 10.0	131	740	2	1.6	0.63	6.4	76478E3
			6.8	8.0 x 8.0 x 10.0	139	870	4	1.33	0.52	4.95	76688E3
			10	8.0 x 8.0 x 10.0	186	1160	4	0.79	0.38	3.2	76109E3
40	25	16	1.0	8.0 x 8.0 x 10.0	94	590	2	3.12	0.86	9.6	77108E3
			2.2	8.0 x 8.0 x 10.0	112	700	2	2.16	0.74	7.5	77228E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage	T_{amb} = 85 °C:	
	at U_R = 4 to 16 V	$U_{rev} < 0.5\ U_R$
	at U_R = 20 V	$U_{rev} < 0.4\ U_R$
	at U_R = 25 to 40 V	$U_{rev} < 0.3\ U_R$
	T_{amb} = 125 °C:	
	at U_R = 4 to 16 V	$U_{rev} < 0.4\ U_R$
	at U_R = 20 V	$U_{rev} < 0.2\ U_R$
	at U_R = 25 to 40 V	$U_{rev} < 0.1\ U_R$
	T_{amb} = 175 °C:	
	at U_R = 4 to 16 V	$U_{rev} < 0.3\ U_R$
	at U_R = 20 V	$U_{rev} < 0.15\ U_R$
	at U_R = 25 to 40 V	$U_{rev} < 0.1\ U_R$
Maximum peak AC voltage	Reverse voltage applied	≤ 2 V
Maximum peak AC voltage, without reverse voltage applied	T_{amb} = 85 °C:	
	at f ≤ 0.1 Hz	0.30 x U_R
	at 0.1 Hz < f ≤ 1 Hz	0.45 x U_R
	at 1 Hz < f ≤ 10 Hz	0.60 x U_R
	at 10 Hz < f ≤ 50 Hz	0.65 x U_R
	at f > 50 Hz	0.80 x U_R
	85 °C < T_{amb} ≤ 125 °C:	
	at f ≤ 0.1 Hz	0.15 x U_R
	at 0.1 Hz < f ≤ 1 Hz	0.22 x U_R
	at 1 Hz < f ≤ 10 Hz	0.30 x U_R
	at 10 Hz < f ≤ 50 Hz	0.32 x U_R
	at f > 50 Hz	0.40 x U_R
	125 °C ≤ T_{amb} ≤ 175 °C:	
	at f < 50 Hz	0.1 x U_R
	at f > 50 Hz	0.2 x U_R
Inductance		
Equivalent series inductance (ESL)	Case sizes (mm):	
	8 x 8 x 10	typ. 9 to 14 nH
Dissipation		
Maximum power dissipation	Case sizes (mm):	$P_{max.} = P_{125}$ mW
	8 x 8 x 10	350
Current		
Maximum leakage current	After 5 minutes at U_R and T_{amb} = 25 °C	see Table 4

VOLTAGE

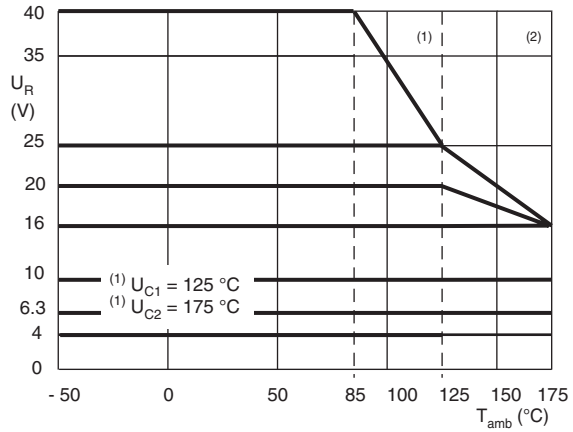
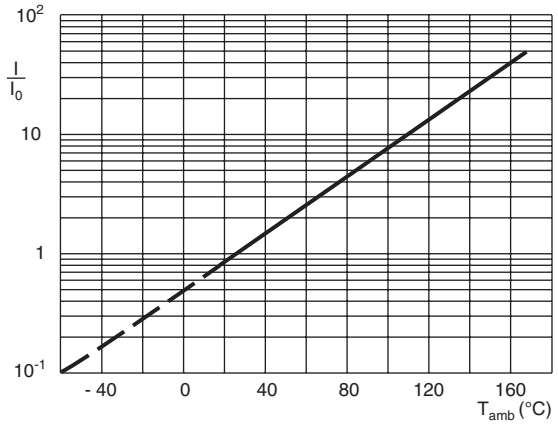


Fig.5 Maximum permissible voltage up to T_{amb} = 175 °C

LEAKAGE CURRENT



I_0 = leakage current during continuous operation at U_R and T_{amb} = 25 °C

Fig.8 Typical multiplier of leakage current as a function of ambient temperature

CAPACITANCE (C)

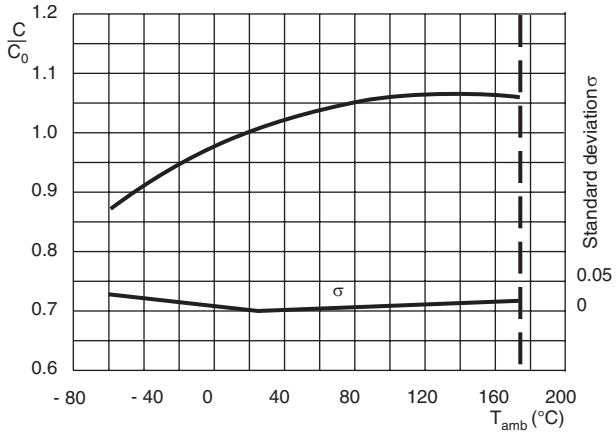


Fig.6 Typical multiplier of capacitance and standard deviation as functions of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

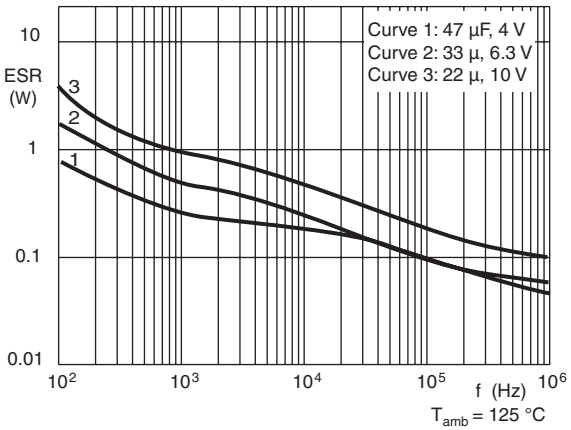
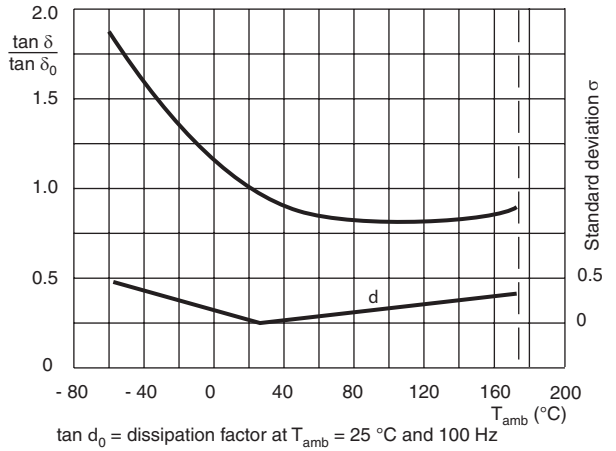


Fig.9 Typical ESR as a function of frequency at 125 °C

DISSIPATION FACTOR (tan δ)



tan d_0 = dissipation factor at T_{amb} = 25 °C and 100 Hz

Fig.7 Typical multiplier of dissipation factor and standard deviation as functions of ambient temperature

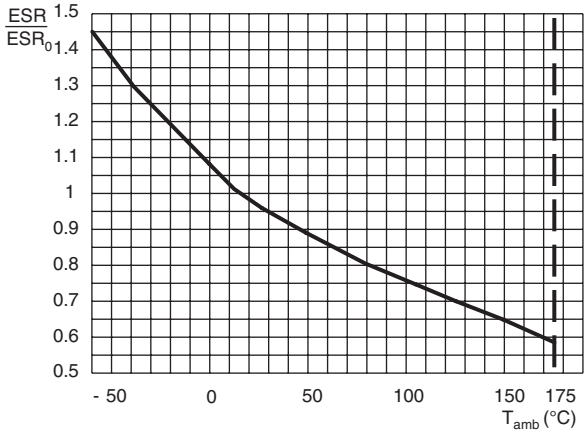


Fig.10 ESR correction multiplier as a function of temperature

IMPEDANCE (Z)

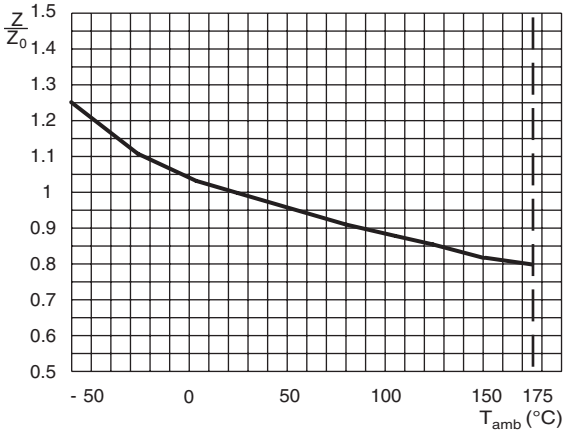


Fig.11 Z correction multiplier as a function of temperature

RIPPLE CURRENT (I_R)

Applying the maximum RMS ripple current given in below table will cause a device temperature of 175 °C.

PARAMETER	T_{amb}					
	40 °C	85 °C	105 °C	125 °C	150 °C	175 °C
I_R multiplier; 100 kHz	1.0	0.87	0.78	0.67	0.5	0.16

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS (1)
NAME OF TEST	REFERENCE		
Mounting	IEC 60384-18, subclause 4.3	shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to chapter “Mounting”	ΔC/C: ± 10 % tan δ ≤ spec. limit I_{L2} ≤ spec. limit
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R = 4 to 25 V with U_R applied; U_R = 40 V with U_C applied; 10 000 h T_{amb} = 175 °C; U_R = 4 to 16 V with U_R applied; U_R = 20 to 40 V with U_C applied; 1000 h	ΔC/C: ± 10 % tan δ ≤ 1.2 x spec. limit Z ≤ 1.2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30302 subclause 1.8.1	T_{amb} = 175 °C; I_R applied and: U_R = 4 to 16 V with U_R applied; U_R = 20 and 40 V with U_C applied; 2000 h	ΔC/C: ± 15 % tan δ ≤ 1.5 x spec. limit Z ≤ 1.5 x spec. limit I_{L5} ≤ spec. limit no short or open circuit, no visible damage total failure percentage: < 1 %
Shelf life (2)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; 500 h	ΔC/C: ± 10 % tan δ ≤ 1.2 x spec. limit I_{L5} ≤ 1 x spec. limit
Charge and discharge	IEC 60384-4-2 subclause 9.21	10^6 cycles without series resistance: 0.5 s to U_R; 0.5 s to ground	ΔC/C: ± 5 % no short or open circuit, no visible damage

Notes
(1) Specification limits on request
(2) MSL acc. J-STD-020D is not specified

TEST PROCEDURES AND REQUIREMENTS

TEST		PROCEDURE (quick reference)	REQUIREMENTS (1)
NAME OF TEST	REFERENCE		
Solvent resistance	IEC 60068-2-45, test XA IEC 60653	immersion: 5 ± 0.5 min with or without ultrasonic at 55 ± 5 °C solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
Vibration	IEC 60068-2-6 test Fc	10 to 2000 Hz; 1.5 mm or 20 g; 1 octave/min; 3 directions; 2 h per direction; no voltage applied	no intermittent contacts no breakdown no open circuiting no mechanical damage $\Delta C/C$: ± 5 % tan $\delta \leq$ 1.2 x spec. limit $Z \leq$ 1.2 x spec. limit $I_{L5} \leq$ 1.5 x spec. limit
Shock	IEC 60068-2-27 test Ea	half-sine or sawtooth pulse shape; 50 g; 11 ms; 3 successive shocks in each direction of 3 mutually perpendicular axes; no voltage applied	no intermittent contacts no breakdown no open circuiting no mechanical damage $\Delta C/C$: ± 5 % tan $\delta \leq$ 1.2 x spec. limit $Z \leq$ 1.2 x spec. limit $I_{L5} \leq$ 1.5 x spec. limit
Bump	IEC 60384-4/ EN 130300 subclass 4.9	40 g; 2 directions; 4000 bumps total	no visible damage $\Delta C/C$: ± 5 % with respect to initial measurement
Passive flammability	IEC 60695-2-2	capacitor mounted to a vertical printed-circuit board, one flame on capacitor body; T_{amb} = 20 to 25 °C; test duration = 20 s	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s no burning particles must drop from the sample

Notes
(1) Specification limits on request
(2) MSL acc. J-STD-020D is not specified

Aluminum Capacitors
Radial Low Profile, 5 mm

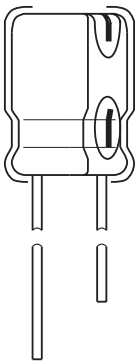
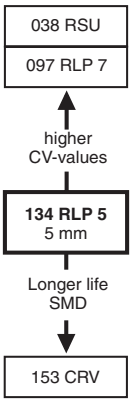


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Very low profile, 5 mm height
- Extremely miniaturized
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

General purpose, industrial, automotive and audio-video

- Coupling, decoupling, smoothing, filtering and timing
- High mounting density
- Portable and mobile equipment (very small size and very low mass), low profile equipment

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Rated voltage (in V)
- Negative terminal identification
- Code indicating factory of origin
- Name of manufacturer
- Date code, in accordance with IEC 60062
- Series number (134)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	4 x 5 to 6.3 x 5
Rated capacitance range, C_R	1.0 to 100 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	- 40 to + 85 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C, 1.4 x I_R applied	40 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
1.0	-	-	-	-	-	4 x 5
2.2	-	-	-	-	-	4 x 5
3.3	-	-	-	-	-	4 x 5
4.7	-	-	-	-	4 x 5	5 x 5
10	-	-	4 x 5	-	5 x 5	6.3 x 5
22	4 x 5	-	5 x 5	-	6.3 x 5	-
33	-	5 x 5	-	6.3 x 5	-	-
47	5 x 5	-	6.3 x 5	-	-	-
100	6.3 x 5	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

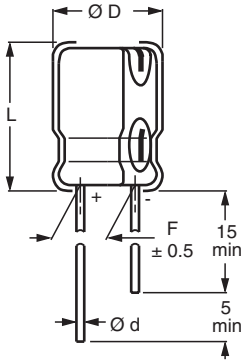
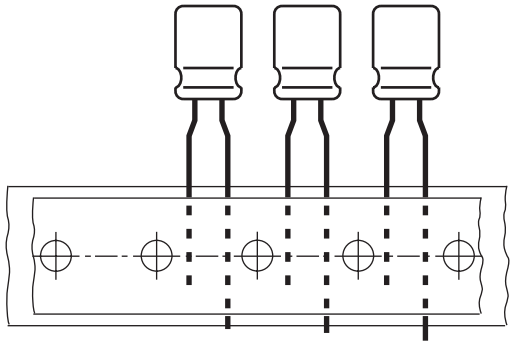
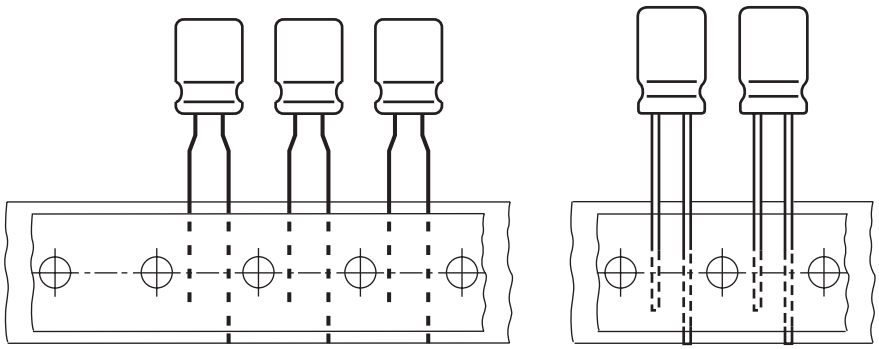


Fig.2 **Form CA**: Long leads



Case Ø D = 4 to 6.3 mm; pitch F = 5 mm

Fig.3 **Form TFA:** Taped in box (ammopack)



pitch F = 2.5 mm
Case ∅ D = 4 to 6.3 mm

Fig.4 **Form TNA:** Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters **AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**PACKAGING QUANTITIES**		
						FORM CA	**FORM TFA**	**FORM TNA**
4 x 5	53	0.45	4.5	6.0	1.5 ± 0.5	2000	2000	2000
5 x 5	54	0.45	5.5	6.0	2.0 ± 0.5	2000	2000	2000
6.3 x 5	55	0.45	6.8	6.0	2.5 ± 0.5	2000	2000	2000

Note
Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA

SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 120 Hz, 85 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 120 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in table apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 134 series

22 µF/16 V; ± 20 %

Nominal case size: Ø 5 x 5 mm; Form TFA

Ordering Code: MAL213435229E3

Former 12NC: 2222 134 35229

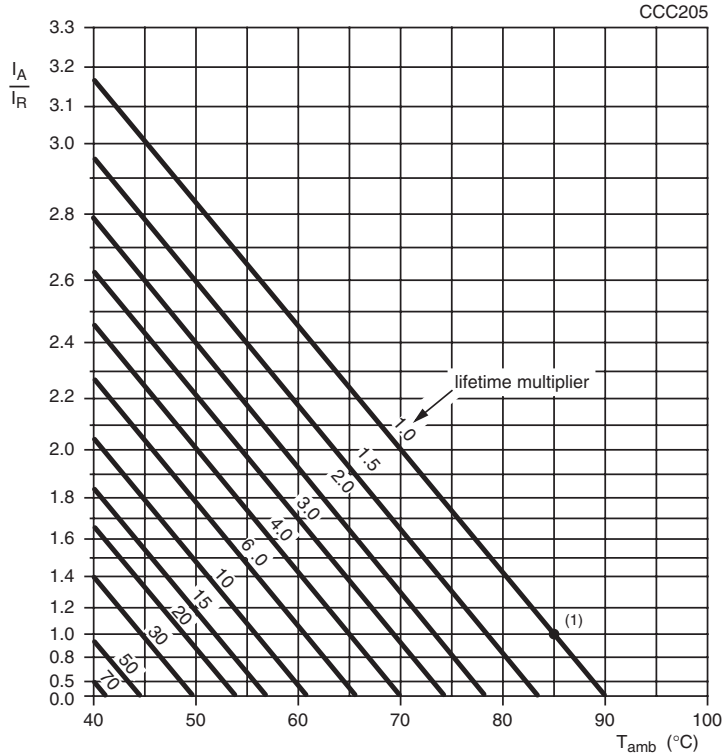
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 120 Hz 85 °C (mA)	I_{L2} 2 min (µA)	tan δ 120 Hz	Z 100 kHz (Ω)	ORDERING CODE MAL2134.....					
							BULK LONG LEADS		TAPED AMMOPACK			
							FORM CA	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
	22	4 x 5	23	3	0.24	11	53229E3	1.5	33229E3	5.0	73229E3	2.5
6.3	47	5 x 5	38	3	0.24	5.2	53479E3	2.0	33479E3	5.0	73479E3	2.5
	100	6.3 x 5	60	7	0.24	3.4	53101E3	2.5	33101E3	5.0	73101E3	2.5
10	33	5 x 5	35	4	0.20	6.0	54339E3	2.0	34339E3	5.0	74339E3	2.5
	10	4 x 5	20	3	0.16	12	95105E3	1.5	95103E3	5.0	95107E3	2.5
16	22	5 x 5	32	4	0.16	6.4	55229E3	2.0	35229E3	5.0	75229E3	2.5
	47	6.3 x 5	50	8	0.16	4.2	55479E3	2.5	35479E3	5.0	75479E3	2.5
25	33	6.3 x 5	45	9	0.14	4.6	56339E3	2.5	36339E3	5.0	76339E3	2.5
	4.7	4 x 5	15	3	0.12	27	50478E3	1.5	30478E3	5.0	70478E3	2.5
35	10	5 x 5	25	4	0.12	17	50109E3	2.0	30109E3	5.0	70109E3	2.5
	22	6.3 x 5	40	8	0.12	11	50229E3	2.5	30229E3	5.0	70229E3	2.5
	1.0	4 x 5	7.5	3	0.10	28	91105E3	1.5	91103E3	5.0	91107E3	2.5
	2.2	4 x 5	12	3	0.10	26	91225E3	1.5	91223E3	5.0	91227E3	2.5
50	3.3	4 x 5	14	3	0.10	25	51338E3	1.5	31338E3	5.0	71338E3	2.5
	4.7	5 x 5	19	3	0.10	22	51478E3	2.0	31478E3	5.0	71478E3	2.5
	10	6.3 x 5	29	5	0.10	14	51109E3	2.5	31109E3	5.0	71109E3	2.5

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$ or 3 µA (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 3)	ESR = tan $\delta / 2\ \pi\ f\ C_R$

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 120 Hz
I_R = rated ripple current at 120 Hz, 85 °C
(1) Useful life at 85 °C and I_R applied: 1500 hours

Fig.5 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 2

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER**
50	0.60
120	1.00
400	1.20
800	1.30
≥ 2000	1.40

Table 3

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300, subclause 4.13	T_{amb} = 85 °C; U_R applied; 1000 hours	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 1500 hours	ΔC/C: ± 50 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L2} ≤ spec. limit no short or open circuit total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_{L2} ≤ spec. limit

Aluminum Capacitors
Radial Low Profile, 7 mm

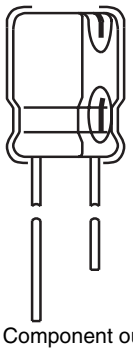


Fig.1 Component outline

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Low profile, 7 mm height
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- General purpose; industrial, automotive and audio-video
- Low surface demand on printed-circuit board
- Coupling, decoupling, smoothing, filtering and timing
- Portable and mobile equipment (small size, low mass), low profile equipment

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Rated voltage (in V)
- Negative terminal identification
- Code indicating factory of origin
- Name of manufacturer
- Date code, in accordance with IEC 60062
- Series number (097)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	4 x 7 to 6.3 x 7
Rated capacitance range, C_R	0.1 to 220 µF
Tolerance on C_R	± 20 %
Rated voltage, U_R	6.3 to 63 V
Category temperature range	- 40 to + 85 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C , 1.4 x I_R applied	40 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)						
	6.3	**10**	**16**	**25**	**35**	**50**	**63**
0.10	-	-	-	-	-	-	4 x 7
0.22	-	-	-	-	-	-	4 x 7
0.47	-	-	-	-	-	-	4 x 7
1.0	-	-	-	-	-	-	4 x 7
2.2	-	-	-	-	-	-	4 x 7
3.3	-	-	-	-	-	4 x 7	5 x 7
4.7	-	-	-	-	4 x 7	5 x 7	6.3 x 7
10	-	-	4 x 7	-	5 x 7	6.3 x 7	6.3 x 7
22	4 x 7	-	5 x 7	-	6.3 x 7	6.3 x 7	-
33	-	5 x 7	-	6.3 x 7	6.3 x 7	-	-
47	5 x 7	-	6.3 x 7	6.3 x 7	-	-	-
100	-	6.3 x 7	6.3 x 7	-	-	-	-
220	6.3 x 7	-	-	-	-	-	-

DIMENSIONS in millimeters, **AND AVAILABLE FORMS**

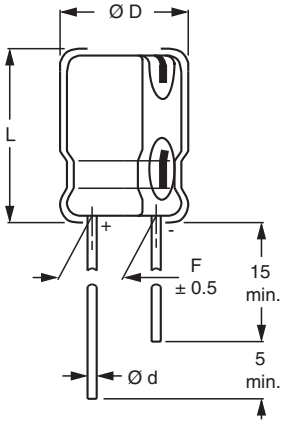


Fig.2 **Form CA**: Long leads

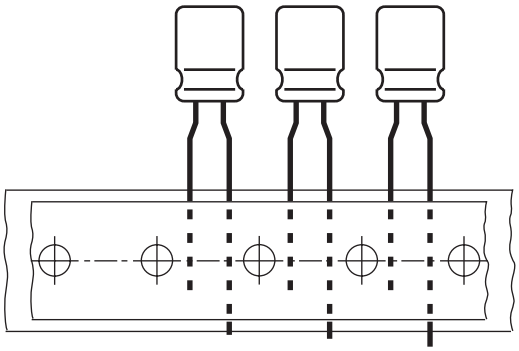


Fig.3 **Form TFA:**
Taped in box (ammopack), formed leads, pitch F = 5 mm

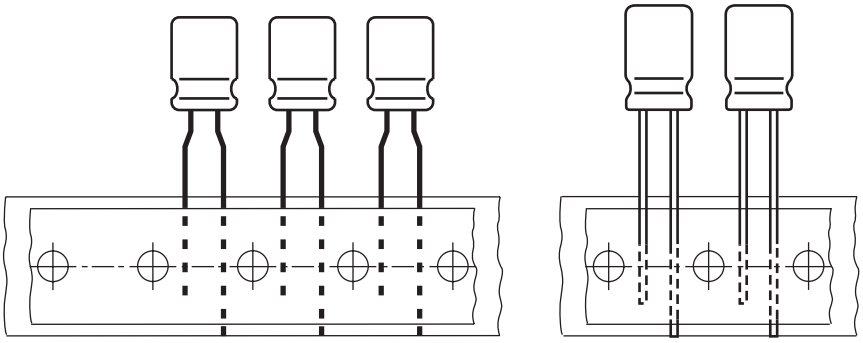


Fig.4 **Form TNA:** Taped in box (ammopack), pitch F = 2.5 mm

DIMENSIONS in millimeters **AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**PACKAGING QUANTITIES**		
						FORM CA	**FORM TFA**	**FORM TNA**
4 x 7	71	0.45	4.5	8	1.5 ± 0.5	2000	2000	2000
5 x 7	72	0.45	5.5	8	2.0 ± 0.5	1000	2000	2000
6.3 x 7	73	0.45	6.8	8	2.5 ± 0.5	1000	2000	2000

Note
Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA

SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 120 Hz, 85 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 120 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 097 series

100 µF/16 V; ± 20 %

Nominal case size: Ø 6.3 x 7 mm; Form TFA

Ordering Code: MAL209735101E6
Former 12NC: 2222 097 35101

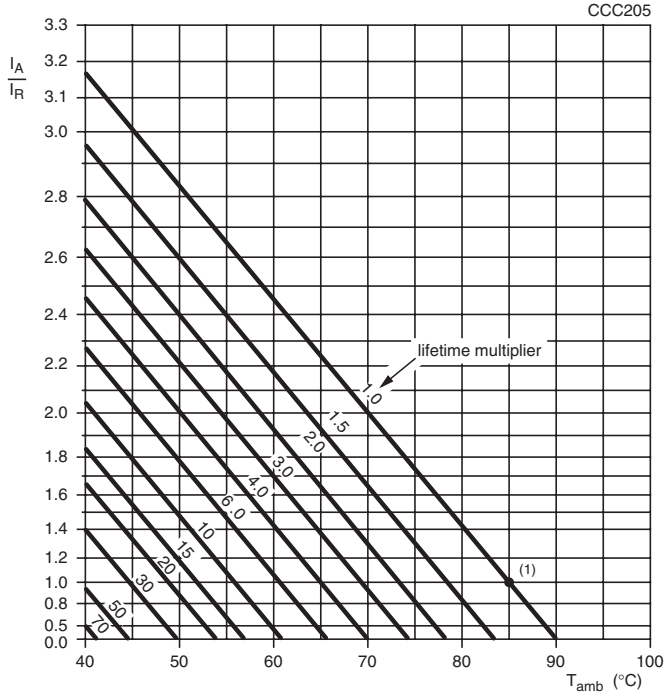
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 120 Hz 85 °C (mA)	I_{L2} 2 min (µA)	tan δ 120 Hz	Z 100 kHz (Ω)	ORDERING CODE MAL2097.....					
							BULK LONG LEADS		TAPED AMMOPACK			
							FORM CA	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	22	4 x 7	31	3	0.24	8.4	53229E6	1.5	33229E6	5.0	73229E6	2.5
	47	5 x 7	47	3	0.24	4.6	53479E6	2.0	33479E6	5.0	73479E6	2.5
	220	6.3 x 7	90	14	0.24	1.8	53221E6	2.5	33221E6	5.0	73221E6	2.5
10	33	5 x 7	43	4	0.20	3.7	54339E6	2.0	34339E6	5.0	74339E6	2.5
	100	6.3 x 7	80	10	0.20	2.2	54101E6	2.5	34101E6	5.0	74101E6	2.5
16	10	4 x 7	25	3	0.16	10	55109E6	1.5	35109E6	5.0	75109E6	2.5
	22	5 x 7	39	4	0.16	5	55229E6	2.0	35229E6	5.0	75229E6	2.5
	47	6.3 x 7	59	8	0.16	3.5	55479E6	2.5	35479E6	5.0	75479E6	2.5
	100	6.3 x 7	90	16	0.16	2.5	55101E6	2.5	35101E6	5.0	75101E6	2.5
25	33	6.3 x 7	53	9	0.14	2.6	56339E6	2.5	36339E6	5.0	76339E6	2.5
	47	6.3 x 7	65	12	0.14	1.9	56479E6	2.5	36479E6	5.0	76479E6	2.5
35	4.7	4 x 7	20	3	0.12	10	50478E6	1.5	30478E6	5.0	70478E6	2.5
	10	5 x 7	30	4	0.12	5.6	50109E6	2.0	30109E6	5.0	70109E6	2.5
	22	6.3 x 7	47	8	0.12	3	50229E6	2.5	30229E6	5.0	70229E6	2.5
	33	6.3 x 7	60	12	0.12	2.6	50339E6	2.5	30339E6	5.0	70339E6	2.5
50	3.3	4 x 7	18	3	0.10	14	51338E6	1.5	31338E6	5.0	71338E6	2.5
	4.7	5 x 7	23	3	0.10	10	51478E6	2.0	31478E6	5.0	71478E6	2.5
	10	6.3 x 7	34	5	0.10	5.5	51109E6	2.5	31109E6	5.0	71109E6	2.5
	22	6.3 x 7	53	11	0.10	2.9	51229E6	2.5	31229E6	5.0	71229E6	2.5
63	0.10	4 x 7	1.3	3	0.08	170	58107E6	1.5	38107E6	5.0	78107E6	2.5
	0.22	4 x 7	2.9	3	0.08	110	58227E6	1.5	38227E6	5.0	78227E6	2.5
	0.47	4 x 7	7.9	3	0.08	66	58477E6	1.5	38477E6	5.0	78477E6	2.5
	1	4 x 7	11	3	0.08	36	58108E6	1.5	38108E6	5.0	78108E6	2.5
	2.2	4 x 7	17	3	0.08	19	58228E6	1.5	38228E6	5.0	78228E6	2.5
	3.3	5 x 7	21	3	0.08	14	58338E6	2.0	38338E6	5.0	78338E6	2.5
	4.7	6.3 x 7	26	3	0.08	10	58478E6	2.5	38478E6	5.0	78478E6	2.5
	10	6.3 x 7	40	7	0.08	5.5	58109E6	2.5	38109E6	5.0	78109E6	2.5

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$ or 3 µA (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta / 2\ \pi\ f\ C_R$

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 120Hz
I_R = rated ripple current at 120 Hz, 85 °C
(1) useful life at 85 °C and I_R applied: 1500 h

Fig.5 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 1

MULTIPLIER OF RIPPLE CURRENT (I_R) (AS A FUNCTION OF FREQUENCY)	
FREQUENCY (Hz)	**I_R MULTIPLIER**
50	0.60
120	1.00
400	1.20
800	1.30
≥ 2000	1.40

Table 2

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300, subclause 4.13	T_{amb} = 85 °C, U_R applied; 1000 h	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied; 1500 h	ΔC/C: ± 50 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L2} ≤ spec. limit no short or open circuit total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 h after test: U_R to be applied for 30 min, 24 to 48 h before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_{L2} ≤ spec. limit

Aluminum Capacitors
Radial Standard Ultra Miniature

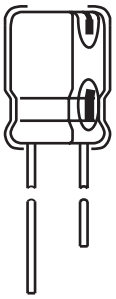
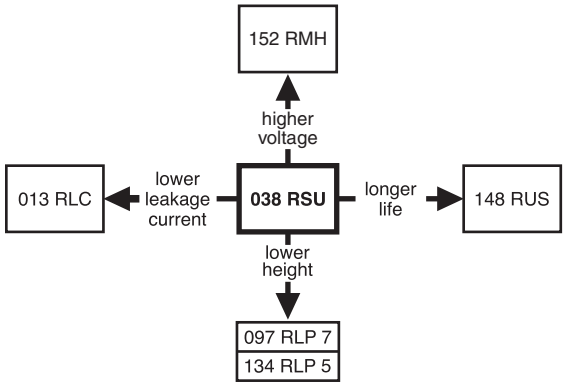


Fig.1 Component outline



QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	5 x 11 to 18 x 40
Rated capacitance range, C_R	0.1 to 22 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	- 40 to + 85 °C
Endurance test at 85 °C:	
case size Ø D ≤ 8 mm	2000 hours
case size Ø D ≥ 10 mm	3000 hours
Useful life at 85 °C:	
case size Ø D ≤ 8 mm	2500 hours
case size Ø D ≥ 10 mm	3500 hours
Useful life at 40 °C, 1.4 x I_R applied:	
case size Ø D ≤ 8 mm	60 000 hours
case size Ø D ≥ 10 mm	90 000 hours
Shelf life at 0 V, 85 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

FEATURES

Pb-free
RoHS COMPLIANT

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue vinyl sleeve
- Pressure relief for case Ø D ≥ 6.3 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant

APPLICATIONS

- General purpose, industrial, automotive, consumer, and audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Portable and mobile equipment (small size, low mass)

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (038)

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
0.1	-	-	-	-	-	-	5 x 11	-
0.22	-	-	-	-	-	-	5 x 11	-
0.33	-	-	-	-	-	-	5 x 11	-
0.47	-	-	-	-	-	-	5 x 11	5 x 11
1.0	-	-	-	-	-	-	5 x 11	5 x 11
2.2	-	-	-	-	-	-	5 x 11	5 x 11
3.3	-	-	-	-	-	-	5 x 11	5 x 11
4.7	-	-	-	-	-	-	5 x 11	5 x 11
10	-	-	-	-	-	-	5 x 11	6.3 x 11
22	-	-	-	-	-	5 x 11	5 x 11	6.3 x 11
33	-	-	-	-	-	5 x 11	6.3 x 11	8 x 11.5
47	-	-	-	-	5 x 11	6.3 x 11	6.3 x 11	10 x 12
100	-	5 x 11	5 x 11	6.3 x 11	6.3 x 11	8 x 11.5	10 x 12	10 x 20
220	5 x 11	5 x 11	6.3 x 11	8 x 11.5	8 x 11.5	10 x 12	10 x 16	13 x 25
330	6.3 x 11	6.3 x 11	8 x 11.5	8 x 11.5	10 x 12	10 x 16	10 x 20	13 x 25
470	6.3 x 11	6.3 x 11	8 x 11.5	10 x 12	10 x 16	10 x 20	13 x 20	16 x 25
1000	8 x 11.5	10 x 12	10 x 16	10 x 20	13 x 20	13 x 25	16 x 25	18 x 40
2200	10 x 16	10 x 20	13 x 20	13 x 25	16 x 25	16 x 31	18 x 35	-
3300	10 x 20	13 x 20	13 x 25	16 x 25	16 x 35	18 x 35	-	-
4700	13 x 20	13 x 25	16 x 25	16 x 31	18 x 35	-	-	-
6800	13 x 25	16 x 25	16 x 31	18 x 35	-	-	-	-
10 000	16 x 25	16 x 35	18 x 35	-	-	-	-	-
22 000	18 x 40	-	-	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS

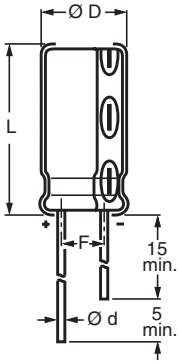


Fig.2 **Form CA**

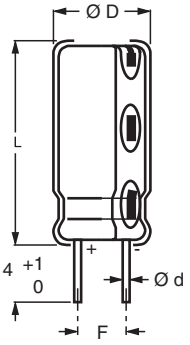
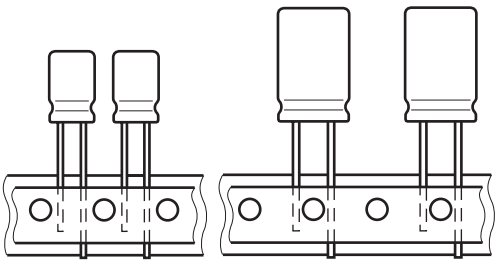
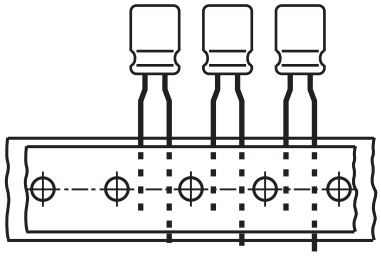


Fig.3 **Form CB:**
Cut leads



Dimensions of pitch F see tables 1 and 2

Fig.4 **Form TNA, Form TFA:**
Taped in box (ammopack), straight leads



Case Ø D = 5 to 8 mm; pitch F is 5 mm

Fig.5 **Form TFA:**
Taped in box (ammopack), formed leads

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES

NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø $D_{max.}$	$L_{max.}$	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA, TNA
5 x 11	11	0.5	5.5	12.5	2.0 ± 0.5	≈ 0.4	5000	-	2000
6.3 x 11	12	0.5	6.8	12.5	2.5 ± 0.5	≈ 0.6	5000	-	2000
8 x 11.5	13	0.6	8.5	12.5	3.5 ± 0.5	≈ 1.1	5000	-	1000
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	3000	1000	500
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	2500	1000	500
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	2000	800	500
13 x 20	17	0.6	13.5	22.0	5.0 ± 0.5	≈ 4.0	1500	400	300
13 x 25	18	0.6	13.5	27.0	5.0 ± 0.5	≈ 5.0	1000	400	300
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	750	200	200
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	600	200	200
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	500	200	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	400	150	-
18 x 40	23	0.8	18.5	42.0	7.5 ± 0.5	≈ 16.0	400	150	-

Note
Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 Hz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 038 series

470 µF/25 V; ± 20 %

Nominal case size: Ø 10 x 12 mm; Form TFA

Ordering Code: MAL203836471E3
Former 12NC: 2222 038 36471

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	ORDERING CODE MAL2038							
						BULK PACKAGING				TAPED AMMOPACK			
						LONG LEADS		CUT LEADS					
						FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	220	5 x 11	200	14	0.23	53221E3	2.0	-	-	33221E3	5.0	73221E3	2.5
	330	6.3 x 11	270	21	0.23	53331E3	2.5	-	-	33331E3	5.0	73331E3	2.5
	470	6.3 x 11	320	30	0.23	53471E3	2.5	-	-	33471E3	5.0	73471E3	2.5
	1000	8 x 11.5	540	63	0.23	53102E3	3.5	-	-	33102E3	5.0	73102E3	3.5
	2200	10 x 16	785	139	0.25	53222E3	5.0	63222E3	5.0	33222E3	5.0	-	-
	3300	10 x 20	1185	208	0.27	53332E3	5.0	63332E3	5.0	33332E3	5.0	-	-
	4700	13 x 20	1545	296	0.29	53472E3	5.0	63472E3	5.0	33472E3	5.0	-	-
	6800	13 x 25	1880	428	0.33	53682E3	5.0	63682E3	5.0	33682E3	5.0	-	-
	10 000	16 x 25	2330	630	0.41	53103E3	7.5	63103E3	7.5	33103E3	7.5	-	-
	22 000	18 x 40	3320	1386	0.65	53223E3	7.5	63223E3	7.5	-	-	-	-
10	100	5 x 11	145	10	0.20	54101E3	2.0	-	-	34101E3	5.0	74101E3	2.5
	220	5 x 11	160	22	0.20	54221E3	2.0	-	-	34221E3	5.0	74221E3	2.5
	330	6.3 x 11	290	33	0.20	54331E3	2.5	-	-	34331E3	5.0	74331E3	2.5
	470	6.3 x 11	350	47	0.20	54471E3	2.5	-	-	34471E3	5.0	74471E3	2.5
	1000	10 x 12	650	100	0.20	54102E3	5.0	64102E3	5.0	34102E3	5.0	-	-
	2200	10 x 20	1070	220	0.22	54222E3	5.0	64222E3	5.0	34222E3	5.0	-	-
	3300	13 x 20	1420	330	0.24	54332E3	5.0	64332E3	5.0	34332E3	5.0	-	-
	4700	13 x 25	1780	470	0.26	54472E3	5.0	64472E3	5.0	34472E3	5.0	-	-
	6800	16 x 25	2220	680	0.30	54682E3	7.5	64682E3	7.5	34682E3	7.5	-	-
	10 000	16 x 35	2760	1000	0.38	54103E3	7.5	64103E3	7.5	-	-	-	-
16	100	5 x 11	160	16	0.16	55101E3	2.0	-	-	35101E3	5.0	75101E3	2.5
	220	6.3 x 11	260	35	0.16	55221E3	2.5	-	-	35221E3	5.0	75221E3	2.5
	330	8 x 11.5	370	53	0.16	55331E3	3.5	-	-	35331E3	5.0	75331E3	3.5
	470	8 x 11.5	440	75	0.16	55471E3	3.5	-	-	35471E3	5.0	75471E3	3.5
	1000	10 x 16	785	160	0.16	55102E3	5.0	65102E3	5.0	35102E3	5.0	-	-
	2200	13 x 20	1295	352	0.18	55222E3	5.0	65222E3	5.0	35222E3	5.0	-	-
	3300	13 x 25	1655	528	0.20	55332E3	5.0	65332E3	5.0	35332E3	5.0	-	-
	4700	16 x 25	2090	752	0.22	55472E3	7.5	65472E3	7.5	35472E3	7.5	-	-
	6800	16 x 31	2520	1088	0.26	55682E3	7.5	65682E3	7.5	35682E3	7.5	-	-
	10 000	18 x 35	2920	1600	0.34	55103E3	7.5	65103E3	7.5	-	-	-	-
25	100	6.3 x 11	190	25	0.14	56101E3	2.5	-	-	36101E3	5.0	76101E3	2.5
	220	8 x 11.5	320	55	0.14	56221E3	3.5	-	-	36221E3	5.0	76221E3	3.5
	330	8 x 11.5	440	83	0.14	56331E3	3.5	-	-	36331E3	5.0	76331E3	3.5
	470	10 x 12	545	118	0.14	56471E3	5.0	66471E3	5.0	36471E3	5.0	-	-
	1000	10 x 20	955	250	0.14	56102E3	5.0	66102E3	5.0	36102E3	5.0	-	-
	2200	13 x 25	1540	550	0.16	56222E3	5.0	66222E3	5.0	36222E3	5.0	-	-
	3300	16 x 25	1975	825	0.18	56332E3	7.5	66332E3	7.5	36332E3	7.5	-	-
	4700	16 x 31	2420	1175	0.20	56472E3	7.5	66472E3	7.5	36472E3	7.5	-	-
	6800	18 x 35	2880	1700	0.24	56682E3	7.5	66682E3	7.5	-	-	-	-

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	ORDERING CODE MAL2038							
						BULK PACKAGING				TAPED AMMOPACK			
						LONG LEADS		CUT LEADS					
						FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
35	47	5 x 11	130	17	0.12	50479E3	2.0	-	-	30479E3	5.0	70479E3	2.5
	100	6.3 x 11	210	35	0.12	50101E3	2.5	-	-	30101E3	5.0	70101E3	2.5
	220	8 x 11.5	385	77	0.12	50221E3	3.5	-	-	30221E3	5.0	70221E3	3.5
	330	10 x 12	490	116	0.12	50331E3	5.0	60331E3	5.0	30331E3	5.0	-	-
	470	10 x 16	740	165	0.12	50471E3	5.0	60471E3	5.0	30471E3	5.0	-	-
	1000	13 x 20	1145	350	0.12	50102E3	5.0	60102E3	5.0	30102E3	5.0	-	-
	2200	16 x 25	1785	770	0.14	50222E3	7.5	60222E3	7.5	30222E3	7.5	-	-
	3300	16 x 35	2275	1155	0.16	50332E3	7.5	60332E3	7.5	-	-	-	-
	4700	18 x 35	2700	1645	0.18	50472E3	7.5	60472E3	7.5	-	-	-	-
50	22	5 x 11	95	11	0.10	51229E3	2.0	-	-	31229E3	5.0	71229E3	2.5
	33	5 x 11	125	17	0.10	51339E3	2.0	-	-	31339E3	5.0	71339E3	2.5
	47	6.3 x 11	165	24	0.10	51479E3	2.5	-	-	31479E3	5.0	71479E3	2.5
	100	8 x 11.5	260	50	0.10	51101E3	3.5	-	-	31101E3	5.0	71101E3	3.5
	220	10 x 12	455	110	0.10	51221E3	5.0	61221E3	5.0	31221E3	5.0	-	-
	330	10 x 16	585	165	0.10	51331E3	5.0	61331E3	5.0	31331E3	5.0	-	-
	470	10 x 20	755	235	0.10	51471E3	5.0	61471E3	5.0	31471E3	5.0	-	-
	1000	13 x 25	1340	500	0.10	51102E3	5.0	61102E3	5.0	31102E3	5.0	-	-
	2200	16 x 31	1885	1100	0.12	51222E3	7.5	61222E3	7.5	31222E3	7.5	-	-
	3300	18 x 35	2500	1650	0.14	51332E3	7.5	61332E3	7.5	-	-	-	-
63	0.10	5 x 11	3.0	3.0	0.09	58107E3	2.0	-	-	38107E3	5.0	78107E3	2.5
	0.22	5 x 11	4.5	3.0	0.09	58227E3	2.0	-	-	38227E3	5.0	78227E3	2.5
	0.33	5 x 11	7.5	3.0	0.09	58337E3	2.0	-	-	38337E3	5.0	78337E3	2.5
	0.47	5 x 11	9.5	3.0	0.09	58477E3	2.0	-	-	38477E3	5.0	78477E3	2.5
	1.0	5 x 11	17	3.0	0.09	58108E3	2.0	-	-	38108E3	5.0	78108E3	2.5
	2.2	5 x 11	28	3.0	0.09	58228E3	2.0	-	-	38228E3	5.0	78228E3	2.5
	3.3	5 x 11	34	3.0	0.09	58338E3	2.0	-	-	38338E3	5.0	78338E3	2.5
	4.7	5 x 11	45	3.0	0.09	58478E3	2.0	-	-	38478E3	5.0	78478E3	2.5
	10	5 x 11	70	6.3	0.09	58109E3	2.0	-	-	38109E3	5.0	78109E3	2.5
	22	5 x 11	105	14	0.09	58229E3	2.0	-	-	38229E3	5.0	78229E3	2.5
	33	6.3 x 11	140	21	0.09	58339E3	2.5	-	-	38339E3	5.0	78339E3	2.5
	47	6.3 x 11	170	30	0.09	58479E3	2.5	-	-	38479E3	5.0	78479E3	2.5
	100	10 x 12	320	63	0.09	58101E3	5.0	68101E3	5.0	38101E3	5.0	-	-
	220	10 x 16	490	139	0.09	58221E3	5.0	68221E3	5.0	38221E3	5.0	-	-
	330	10 x 20	710	208	0.09	58331E3	5.0	68331E3	5.0	38331E3	5.0	-	-
	470	13 x 20	900	296	0.09	58471E3	5.0	68471E3	5.0	38471E3	5.0	-	-
	1000	16 x 25	1560	630	0.09	58102E3	7.5	68102E3	7.5	38102E3	7.5	-	-
	2200	18 x 35	1950	1386	0.11	58222E3	7.5	68222E3	7.5	-	-	-	-
100	0.47	5 x 11	12	3.0	0.08	59477E3	2.0	-	-	39477E3	5.0	79477E3	2.5
	1.0	5 x 11	22	3.0	0.08	59108E3	2.0	-	-	39108E3	5.0	79108E3	2.5
	2.2	5 x 11	33	3.0	0.08	59228E3	2.0	-	-	39228E3	5.0	79228E3	2.5
	3.3	5 x 11	40	3.3	0.08	59338E3	2.0	-	-	39338E3	5.0	79338E3	2.5
	4.7	5 x 11	48	4.7	0.08	59478E3	2.0	-	-	39478E3	5.0	79478E3	2.5
	10	6.3 x 11	80	10	0.08	59109E3	2.5	-	-	39109E3	5.0	79109E3	2.5
	22	6.3 x 11	115	22	0.08	59229E3	2.5	-	-	39229E3	5.0	79229E3	2.5
	33	8 x 11.5	145	33	0.08	59339E3	3.5	-	-	39339E3	5.0	79339E3	3.5
	47	10 x 12	235	47	0.08	59479E3	5.0	69479E3	5.0	39479E3	5.0	-	-
	100	10 x 20	370	100	0.08	59101E3	5.0	69101E3	5.0	39101E3	5.0	-	-
	220	13 x 25	675	220	0.08	59221E3	5.0	69221E3	5.0	39221E3	5.0	-	-
	330	13 x 25	825	330	0.08	59331E3	5.0	69331E3	5.0	39331E3	5.0	-	-
	470	16 x 25	1070	470	0.08	59471E3	7.5	69471E3	7.5	39471E3	7.5	-	-
	1000	18 x 40	2410	1000	0.08	59102E3	7.5	69102E3	7.5	-	-	-	-

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$ or 3 µA, whichever is greater
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D ≤ 8 mm	typ. 13 nH
	Case Ø D = 10 mm	typ. 16 nH
	Case Ø D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)

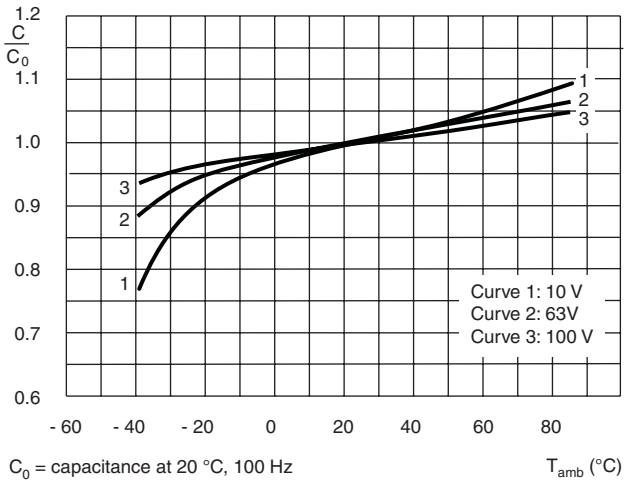


Fig.6 Typical multiplier of capacitance as a function of ambient temperature

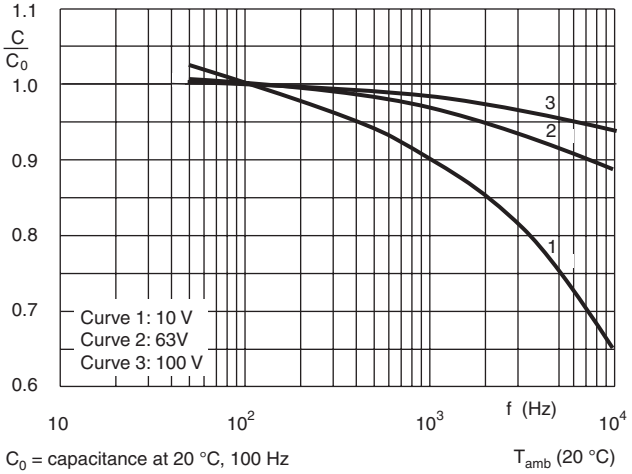


Fig.7 Typical multiplier of capacitance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 85 °C
Useful life at 85 °C and I_R applied:
case Ø D ≤ 8 mm: 2500 h
case Ø D ≥ 10 mm: 3500 h

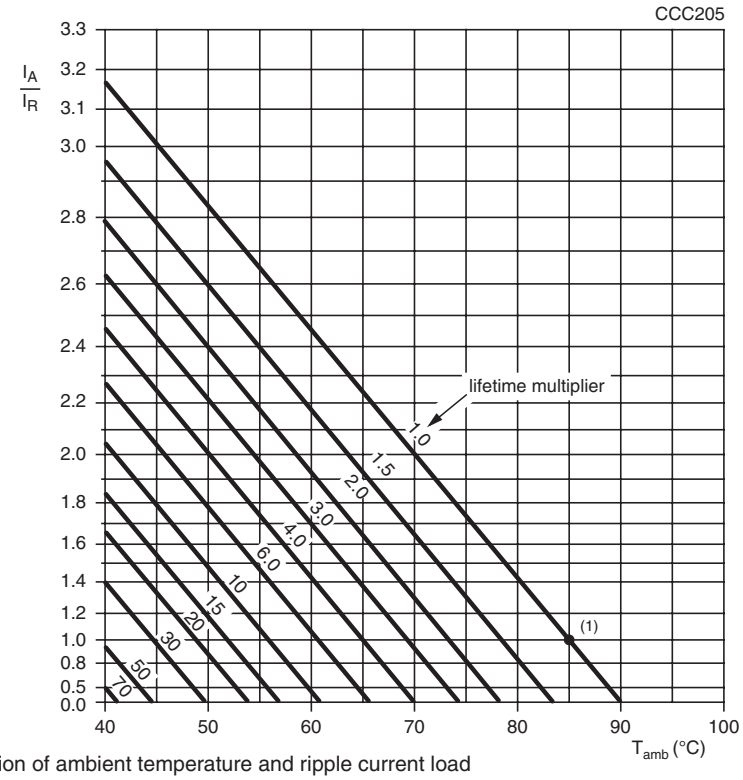


Fig.8 Multiplier of useful life as afunction of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	**I_R MULTIPLIER**		
	C_R < 100 µF	**C_R = 100 to 1000 µF**	**C_R > 1000 µF**
50	0.70	0.75	0.80
100	1.00	1.00	1.00
500	1.30	1.20	1.10
1000	1.40	1.30	1.12
≥ 10 000	1.50	1.35	1.15

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; case Ø ≤ 8 mm: 2000 h case Ø ≥ 10 mm: 3000 h	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; case Ø ≤ 8 mm: 2500 h case Ø ≥ 10 mm: 3500 h	ΔC/C: ± 50 % tan δ ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 1000 h after test: U_R to be applied for 30 min, 24 to 48 h before measurement	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L5} ≤ 3 x spec. limit
Surge	IEC 60384-4/ EN130300 subclause 4.14	from source of 1.15 x U_R: RC = 0.1 ± 0.05 s; 1000 cycles of 30 s on, 330 s off, at 85 °C	ΔC/C: ± 25 % tan δ ≤ 1.5 x spec. limit I_{L5} ≤ spec. limit

Aluminum Capacitors
Radial Low Leakage Current

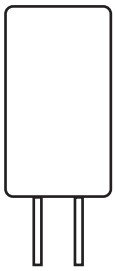
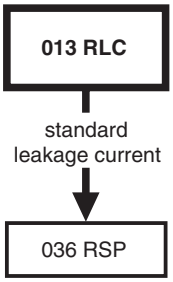


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Low leakage current, low energy consumption
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Telecommunication, automotive, audio-video, EDP and industrial
- Coupling, decoupling, buffering, timing, energy storage
- Portable and mobile equipment
- Low surface demand on printed-circuit board

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Minus-sign on top to identify the negative terminal
- Series number (013)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	5 x 11 and 8.2 x 11
Rated capacitance range, C_R	0.47 to 470 µF
Tolerance on C_R	± 20 %; ± 10 % on request
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	- 40 to + 85 °C
Leakage current after 2 minutes: U_R = 6.3 to 25 V U_R = 35 and 50 V	 0.002 C_R x U_R or 0.7 µA, whichever is greater 0.002 C_R x U_R + 1 µA
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	750 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 x I_R applied	80 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
0.47	-	-	-	-	-	5 x 11
1.0	-	-	-	5 x 11	-	5 x 11
2.2	-	-	-	5 x 11	-	5 x 11
3.3	-	-	-	5 x 11	-	5 x 11
4.7	-	-	-	5 x 11	-	5 x 11
10	-	-	-	5 x 11	-	5 x 11
22	-	-	-	5 x 11	-	5 x 11
33	-	-	5 x 11	-	5 x 11	8.2 x 11
47	-	5 x 11	5 x 11	8.2 x 11	-	8.2 x 11
68	-	5 x 11	-	-	-	8.2 x 11
100	-	5 x 11	-	-	8.2 x 11	-
220	-	8.2 x 11	-	-	-	-
330	8.2 x 11	-	-	-	-	-
470	8.2 x 11	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

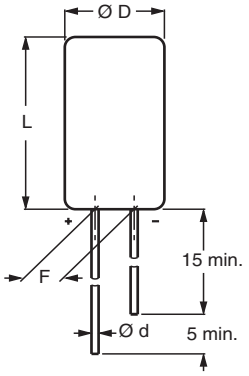


Fig.2 **Form CA:** Long leads

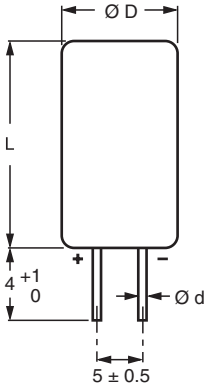
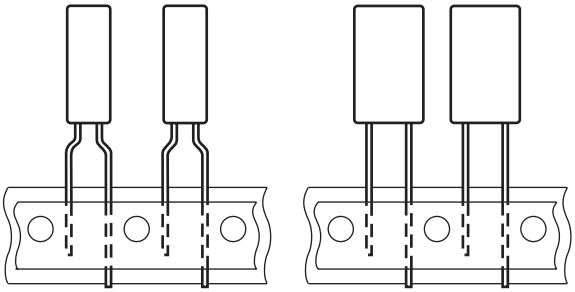
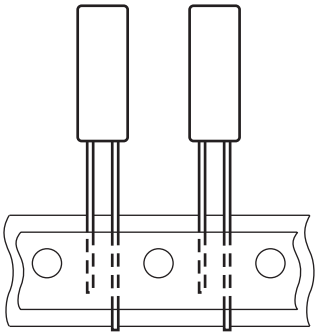


Fig.3 **Form CB:** Cut leads



Case Ø D x L = 5 x11 and 8.2 x 11mm
Pitch F = 5 mm

Fig.4 **Form TFA:** Taped in box (ammopack)



Case Ø D x L = 5 x11 mm only
Pitch F = 2.5 mm

Fig.5 **Form TFA:** Taped in box (ammopack)

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**	
							FORM CA, CB	**FORM TFA, TNA**
5 x 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 x 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Note
Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz and + 20 °C

Note
Unless otherwise specified, all electrical values in Table 1 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 013 series

100 µF/16 V; ± 20 %

Nominal case size: Ø 8.2 x 11 mm; Form TFA

Ordering Code: MAL201335101E3
Former 12NC: 2222 013 35101

Table 1

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2013.....							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS					
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	330	8.2 x 11	210	4.2	0.2	0.9	53331E3	5.0	63331E3	5.0	33331E3	5.0	-	-
	470	8.2 x 11	250	5.9	0.2	0.64	53471E3	5.0	63471E3	5.0	33471E3	5.0	-	-
10	47	5 x 11	75	1.0	0.16	2.8	54479E3	2.5	-	-	34479E3	5.0	74479E3	2.5
	68	5 x 11	90	1.4	0.16	2.5	54689E3	2.5	-	-	34689E3	5.0	74689E3	2.5
	100	5 x 11	110	2.0	0.16	1.7	54101E3	2.5	-	-	34101E3	5.0	74101E3	2.5
	220	8.2 x 11	190	4.4	0.16	0.9	54221E3	5.0	64221E3	5.0	34221E3	5.0	-	-
16	33	5 x 11	70	1.1	0.13	2.8	55339E3	2.5	-	-	35339E3	5.0	75339E3	2.5
	47	5 x 11	85	1.5	0.13	2.1	55479E3	2.5	-	-	35479E3	5.0	75479E3	2.5
	100	8.2 x 11	150	3.2	0.13	1.0	55101E3	5.0	65101E3	5.0	35101E3	5.0	-	-
25	1.0	5 x 11	5	0.7	0.06	40	56108E3	2.5	-	-	36108E3	5.0	76108E3	2.5
	2.2	5 x 11	10	0.7	0.06	18	56228E3	2.5	-	-	36228E3	5.0	76228E3	2.5
	3.3	5 x 11	18	0.7	0.06	12	56338E3	2.5	-	-	36338E3	5.0	76338E3	2.5
	4.7	5 x 11	25	0.7	0.06	8.5	56478E3	2.5	-	-	36478E3	5.0	76478E3	2.5
	10	5 x 11	50	0.7	0.06	4.0	56109E3	2.5	-	-	36109E3	5.0	76109E3	2.5
	22	5 x 11	75	1.1	0.08	2.7	56229E3	2.5	-	-	36229E3	5.0	76229E3	2.5
	47	8.2 x 11	130	2.4	0.08	1.3	56479E3	5.0	66479E3	5.0	36479E3	5.0	-	-
35	33	5 x 11	70	3.3	0.13	2.8	50339E3	5.0	-	-	30339E3	5.0	70339E3	2.5
	100	8.2 x 11	150	8.0	0.13	1.0	50101E3	5.0	60101E3	5.0	30101E3	5.0	-	-
50	0.47	5 x 11	5	1.1	0.06	85	51477E3	2.5	-	-	31477E3	5.0	71477E3	2.5
	1.0	5 x 11	10	1.1	0.06	40	51108E3	2.5	-	-	31108E3	5.0	71108E3	2.5
	2.2	5 x 11	20	1.2	0.06	18	51228E3	2.5	-	-	31228E3	5.0	71228E3	2.5
	3.3	5 x 11	32	1.3	0.06	12	51338E3	2.5	-	-	31338E3	5.0	71338E3	2.5
	4.7	5 x 11	38	1.5	0.06	8.5	51478E3	2.5	-	-	31478E3	5.0	71478E3	2.5
	10	5 x 11	55	2.0	0.06	4.0	51109E3	2.5	-	-	31109E3	5.0	71109E3	2.5
	22	5 x 11	75	3.2	0.08	2.7	51229E3	2.5	-	-	31229E3	5.0	71229E3	2.5
	33	8.2 x 11	110	4.3	0.06	1.4	51339E3	5.0	61339E3	5.0	31339E3	5.0	-	-
	47	8.2 x 11	130	5.7	0.08	1.3	51479E3	5.0	61479E3	5.0	31479E3	5.0	-	-
	68	8.2 x 11	150	7.8	0.08	1.2	51689E3	5.0	61689E3	5.0	31689E3	5.0	-	-

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.3 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R: U_R = 6.3 to 25 V U_R = 35 and 50 V	 $I_{L2} \leq 0.002\ C_R \times U_R$ or 0.7 µA, whichever is greater $I_{L2} \leq 0.002\ C_R \times U_R + 1$ µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D x L = 5 x 11 mm	typ. 13 nH
	Case Ø D x L = 8.2 x 11 mm	typ. 16 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 1)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)

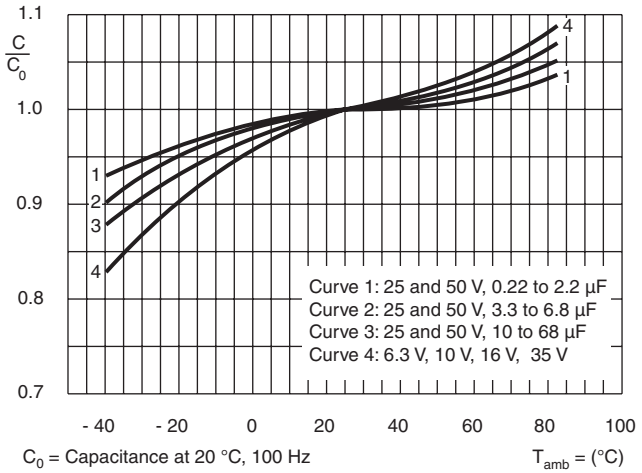


Fig.6 Typical multiplier of capacitance as a function of ambient temperature

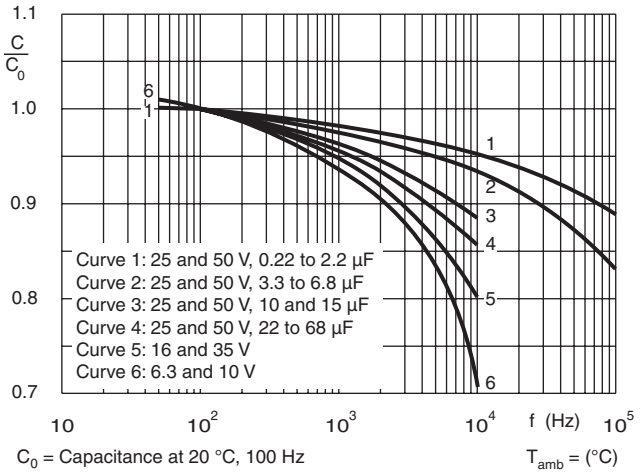


Fig.7 Typical multiplier of capacitance as a function of frequency

LEAKAGE CURRENT

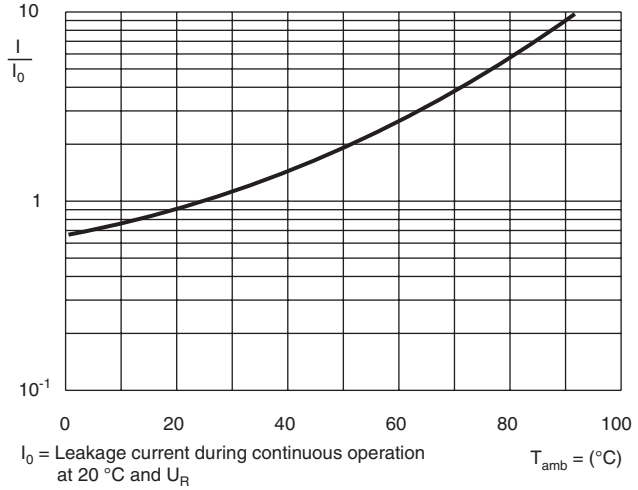


Fig.8 Typical multiplier of leakage current a function of ambient temperature

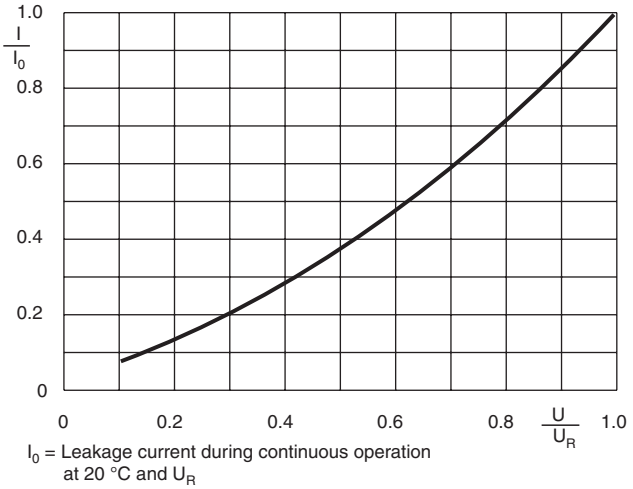


Fig.9 Typical multiplier of leakage current as a function of time

LEAKAGE CURRENT

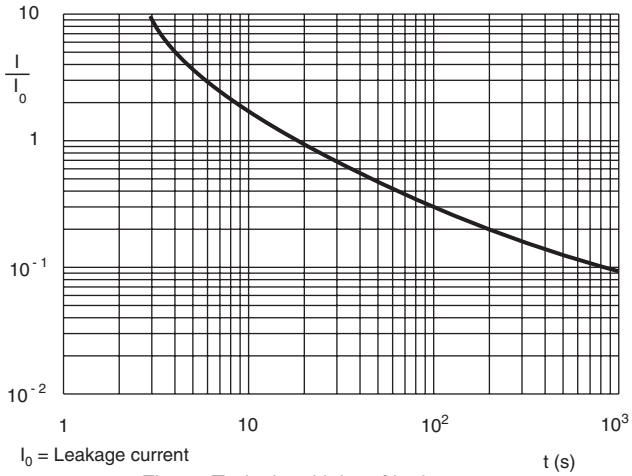
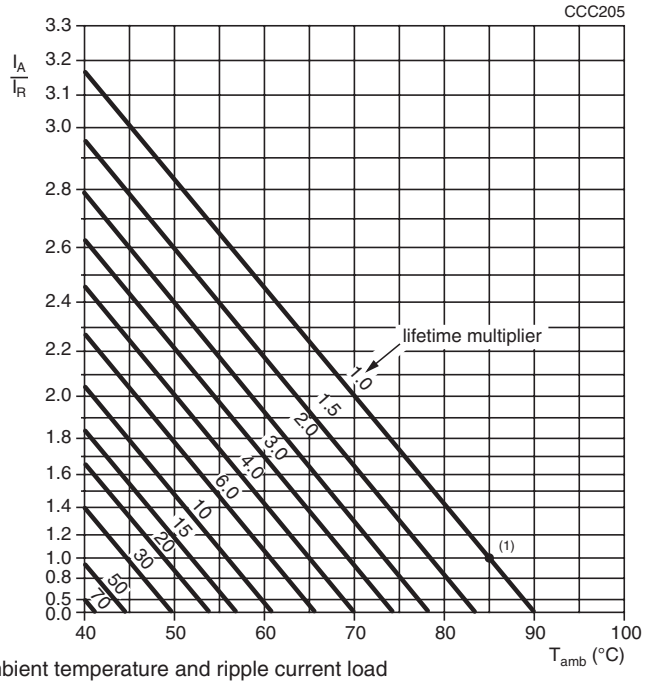


Fig.10 Typical multipler of leakage current a function of time

RIPPLE CURRENT AND USEFUL LIFE



I_A = Actual riple current at 100 Hz

I_R = Ripple current at 85 °C, 100 Hz

(1) Useful life at 85 °C and I_R ripple current load

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 2

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 V	U_R = 10, 16 and 35 V	U_R = 25 and 50 V
50	0.90	0.85	0.80
100	1.00	1.00	1.00
300	1.12	1.20	1.25
1000	1.20	1.30	1.40
3000	1.25	1.35	1.50
≥ 10 000	1.30	1.40	1.60

Table 3

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300, subclause 4.13	T_{amb} = 85 °C; U_R applied; 2000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: + 15/- 30 % $U_R > 6.3$ V; $\Delta C/C$: ± 15 % tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L2} \leq$ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 3000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: + 45/- 50 % $U_R > 6.3$ V; $\Delta C/C$: ± 45 % tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L2} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L2} \leq 2$ x spec. limit

Aluminum Capacitors
Radial Semi-Professional

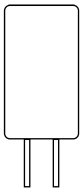
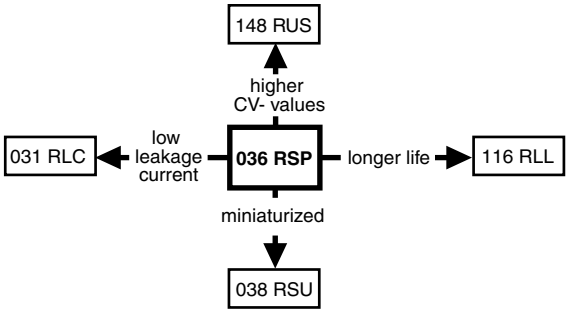


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Reduced leakage current
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Automotive, telecommunication, industrial, EDP and audio-video
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Portable and mobile equipment (small size, low mass)

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Minus-sign on top to identify the negative terminal
- Series number (036)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	5 x 11 and 8.2 x 11
Rated capacitance range, C_R	0.47 to 470 µF
Tolerance on C_R	± 20 %; ± 10 % on request
Rated voltage range, U_R	6.3 to 160 V
Category temperature range	- 55 to + 85 °C
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	750 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 x I_R applied	80 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130 300
Climatic category IEC 60068	55/085/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)									
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**	**160**
0.47	-	-	-	-	-	-	-	5 x 11	-	-
1.0	-	-	-	-	-	-	-	5 x 11	-	-
2.2	-	-	-	-	-	-	-	5 x 11	-	8.2 x 11
3.3	-	-	-	-	-	-	-	5 x 11	-	-
4.7	-	-	-	-	-	-	-	5 x 11	-	8.2 x 11
6.8	-	-	-	-	-	-	-	5 x 11	-	-
10	-	-	-	-	-	-	5 x 11	5 x 11	8.2 x 11	-
	-	-	-	-	-	-	-	8.2 x 11	-	-
15	-	-	-	-	-	5 x 11	-	5 x 11	-	-
22	-	-	-	-	5 x 11	-	-	5 x 11	8.2 x 11	-
	-	-	-	-	-	-	-	8.2 x 11	-	-
33	-	-	5 x 11	-	-	-	5 x 11	8.2 x 11	-	-
47	-	5 x 11	-	-	5 x 11	-	8.2 x 11	8.2 x 11	-	-
68	-	-	-	5 x 11	-	8.2 x 11	-	8.2 x 11	-	-
100	5 x 11	-	5 x 11	8.2 x 11	-	-	8.2 x 11	-	-	-
150	-	5 x 11	8.2 x 11	-	8.2 x 11	-	-	-	-	-
220	-	8.2 x 11	8.2 x 11	8.2 x 11	-	-	-	-	-	-
330	8.2 x 11	-	8.2 x 11	-	-	-	-	-	-	-
470	-	8.2 x 11	-	-	-	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

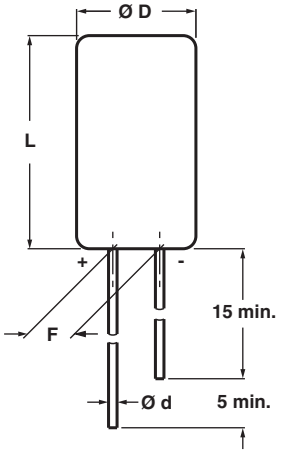
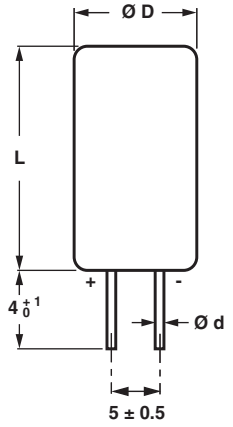
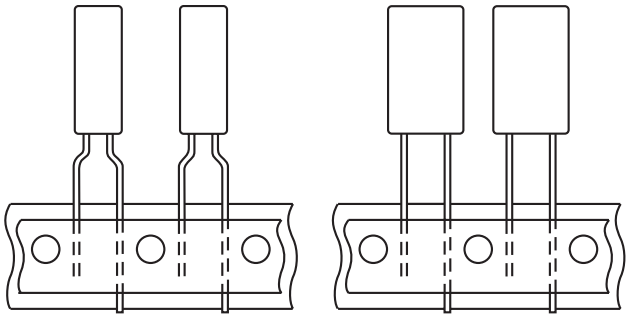


Fig.2 **Form CA:** Long leads



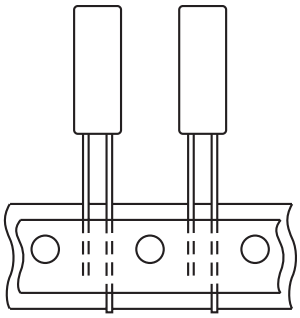
Case Ø D x L = 8.2 x 11 mm only

Fig.3 **Form CB:** Cut leads



Pitch F = 5 mm
Case Ø D x L = 5 x 11 and 8.2 x 11 mm

Fig.4 **Form TFA:** Taped in box (AMMOPACK)



Pitch F = 2.5 mm
Case Ø D x L = 5 x 11 mm only

Fig.5 **Form TNA:** Taped in box (AMMOPACK)

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**	
							FORM CA, CB	**FORM TFA, TNA**
5 x 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 x 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Note

1. Tape dimensions see section ‘PACKAGING’

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz, tolerance ± 20 %
I_R	Rated RMS ripple current at 100 Hz, 85 °C
I_{L1}	Max. leakage current after 1 minute at U_R
tan δ	Max. dissipation factor at 100 Hz
Z	Max. impedance at 10 kHz and 20 °C

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%

ORDERING EXAMPLE

Electrolytic capacitor 036 series

100 µF/16 V; ± 20 %

Nominal case size: Ø 5 x 11 mm; Form TFA

Ordering code: MAL203635101E3

Former 12NC: 2222 036 35101

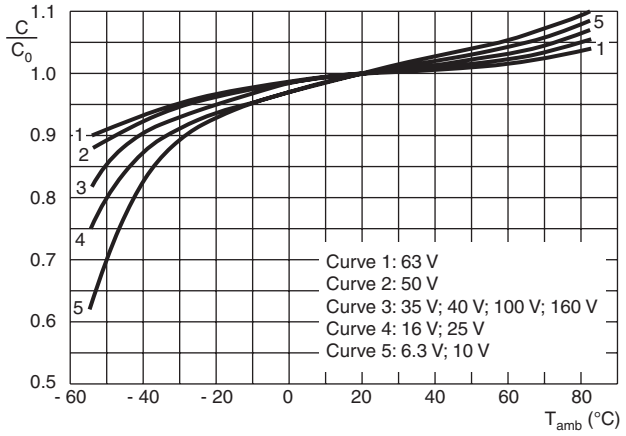
Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2036.....							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS					
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	100	5 x 11	130	7	0.20	1.7	53101E3	2.5	-	-	33101E3	5.0	73101E3	2.5
	330	8.2 x 11	300	16	0.20	0.52	53331E3	5.0	63331E3	5.0	33331E3	5.0	-	-
10	47	5 x 11	95	6	0.16	2.8	54479E3	2.5	-	-	34479E3	5.0	74479E3	2.5
	150	5 x 11	150	12	0.20	1.3	54151E3	2.5	-	-	34151E3	5.0	74151E3	2.5
	220	8.2 x 11	260	17	0.16	0.59	54221E3	5.0	64221E3	5.0	34221E3	5.0	-	-
	470	8.2 x 11	400	31	0.20	0.43	54471E3	5.0	64471E3	5.0	34471E3	5.0	-	-
16	33	5 x 11	90	7	0.14	2.7	55339E3	2.5	-	-	35339E3	5.0	75339E3	2.5
	100	5 x 11	160	13	0.16	1.6	55101E3	2.5	-	-	35101E3	5.0	75101E3	2.5
	150	8.2 x 11	230	18	0.14	0.6	55151E3	5.0	65151E3	5.0	35151E3	5.0	-	-
	220	8.2 x 11	280	24	0.16	0.55	55221E3	5.0	65221E3	5.0	35221E3	5.0	-	-
	330	8.2 x 11	390	35	0.16	0.48	55331E3	5.0	65331E3	5.0	35331E3	5.0	-	-
25	68	5 x 11	140	13	0.14	1.8	56689E3	2.5	-	-	36689E3	5.0	76689E3	2.5
	100	8.2 x 11	210	18	0.12	0.7	56101E3	5.0	66101E3	5.0	36101E3	5.0	-	-
	220	8.2 x 11	310	36	0.14	0.55	56221E3	5.0	66221E3	5.0	36221E3	5.0	-	-
35	22	5 x 11	87	8	0.10	2.7	90001E3	2.5	-	-	90027E3	5.0	90389E3	2.5
	47	5 x 11	130	13	0.12	1.9	90094E3	2.5	-	-	90098E3	5.0	90391E3	2.5
	150	8.2 x 11	270	35	0.12	0.6	90099E3	5.0	90101E3	5.0	90103E3	5.0	-	-
40	15	5 x 11	72	7	0.10	3.7	57159E3	2.5	-	-	37159E3	5.0	77159E3	2.5
	68	8.2 x 11	180	20	0.10	0.81	57689E3	5.0	67689E3	5.0	37689E3	5.0	-	-
50	10	5 x 11	60	6	0.08	4.5	90004E3	2.5	-	-	90028E3	5.0	90392E3	2.5
	33	5 x 11	110	13	0.10	2.1	90104E3	2.5	-	-	90108E3	5.0	90393E3	2.5
	47	8.2 x 11	160	18	0.08	0.96	90011E3	5.0	90012E3	5.0	90031E3	5.0	-	-
	100	8.2 x 11	250	33	0.10	0.7	90109E3	5.0	90111E3	5.0	90113E3	5.0	-	-
63	0.47	5 x 11	5	4	0.06	85	58477E3	2.5	-	-	38477E3	5.0	78477E3	2.5
	1.0	5 x 11	11	4	0.06	40	58108E3	2.5	-	-	38108E3	5.0	78108E3	2.5
	2.2	5 x 11	25	4	0.06	18	58228E3	2.5	-	-	38228E3	5.0	78228E3	2.5
	3.3	5 x 11	38	5	0.06	12	58338E3	2.5	-	-	38338E3	5.0	78338E3	2.5
	4.7	5 x 11	45	5	0.06	8.5	58478E3	2.5	-	-	38478E3	5.0	78478E3	2.5
	6.8	5 x 11	55	6	0.06	5.9	58688E3	2.5	-	-	38688E3	5.0	78688E3	2.5
	10	5 x 11	70	7	0.06	4.0	58109E3	2.5	-	-	38109E3	5.0	78109E3	2.5
	10	8.2 x 11	120	7	0.04	2.8	90036E3	5.0	90041E3	5.0	90181E3	5.0	-	-
	15	5 x 11	80	9	0.07	3.1	58159E3	2.5	-	-	38159E3	5.0	78159E3	2.5
	22	5 x 11	100	11	0.08	2.7	58229E3	2.5	-	-	38229E3	5.0	78229E3	2.5
	22	8.2 x 11	150	11	0.05	1.4	90117E3	5.0	90118E3	5.0	90139E3	5.0	-	-
	33	8.2 x 11	160	16	0.06	1.2	58339E3	5.0	68339E3	5.0	38339E3	5.0	-	-
	47	8.2 x 11	190	21	0.07	1.0	58479E3	5.0	68479E3	5.0	38479E3	5.0	-	-
	68	8.2 x 11	210	29	0.08	0.88	58689E3	5.0	68689E3	5.0	38689E3	5.0	-	-
100	10	8.2 x 11	80	9	0.06	3.5	59109E3	5.0	69109E3	5.0	39109E3	5.0	-	-
	22	8.2 x 11	110	16	0.06	1.8	59229E3	5.0	69229E3	5.0	39229E3	5.0	-	-
160	2.2	8.2 x 11	45	75	0.05	14	90333E3	5.0	90334E3	5.0	90336E3	5.0	-	-
	4.7	8.2 x 11	62	115	0.07	9.6	90337E3	5.0	90338E3	5.0	90341E3	5.0	-	-

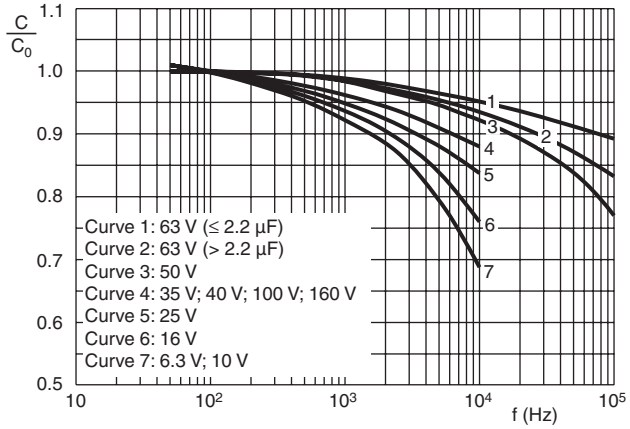
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minute U_R = 6.3 to 100 V U_R = 160 V	 $I_{L1} \leq 0.006\ C_R \times U_R + 3\ \mu A$ $I_{L1} \leq 0.1\ C_R \times U_R + 40\ \mu A$
	After 5 minutes U_R = 6.3 to 100 V U_R = 160 V	 $I_{L5} \leq 0.001\ C_R \times U_R + 3\ \mu A$ $I_{L5} \leq 0.015\ C_R \times U_R + 10\ \mu A$
Inductance		
Equivalent series inductance (ESL)	Case Ø D x L = 5 x 11 mm	Typ. 13 nH
	Case Ø D x L = 8.2 x 11 mm	Typ. 16 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)



C_0 = Capacitance at 20 °C, 100 Hz

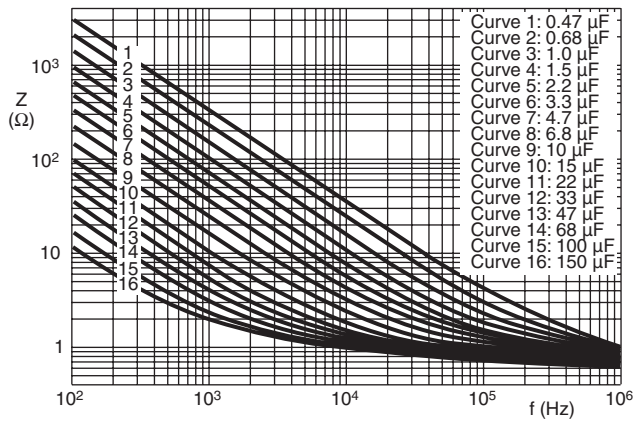
Fig.6 Typical multiplier of capacitance as a function of ambient temperature



C_0 = Capacitance at 20 °C, 100 Hz T_{amb} = 20 °C

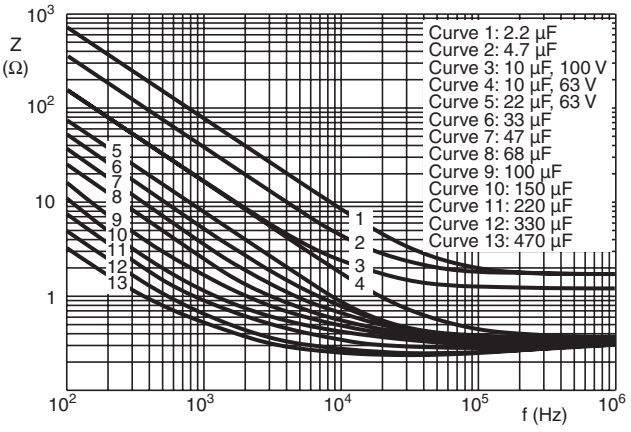
Fig.7 Typical multiplier of capacitance as a function of ambient temperature

IMPEDANCE (Z)



Case Ø D x L = 5 x 11 mm T_{amb} = 20 °C

Fig.8 Typical impedance as a function of frequency



Case Ø D x L = 8.2 x 11 mm T_{amb} = 20 °C

Fig.9 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

I_A = Actual ripple current at 100 Hz

I_R = Rated ripple current at 100 Hz, 85 °C

(1) Useful life at 85 °C and I_R applied: 3000 hours

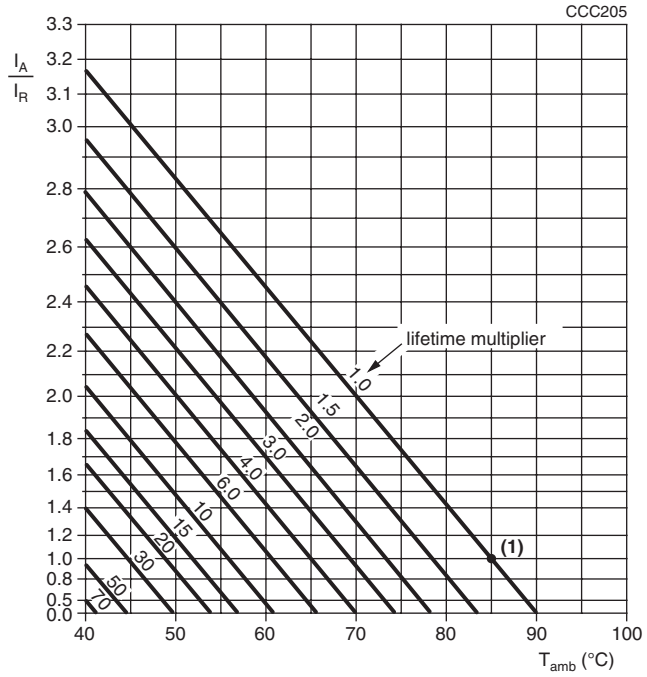


Fig.10 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 35 V	U_R = 40 to 160 V
50	0.90	0.85	0.80
100	1.00	1.00	1.00
300	1.12	1.20	1.25
1000	1.20	1.30	1.40
3000	1.25	1.35	1.50
≥ 10 000	1.30	1.40	1.60

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; 2000 h	$U_R \leq$ 6.3 V; ΔC/C: + 15/- 30 % $U_R >$ 6.3 V; ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 3000 h	$U_R \leq$ 6.3 V; ΔC/C: + 45/- 50 % $U_R >$ 6.3 V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit $I_{L5} \leq$ spec. limit No short or open circuit Total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 h After test: U_R to be applied for 30 min, 24 to 48 h before measurement	ΔC/C, tan δ, Z: For requirements See 'Endurance test' above $I_{L5} \leq$ spec. limit

Aluminum Capacitors
Radial, Ultra High CV per Volume, Semi-Professional

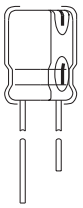
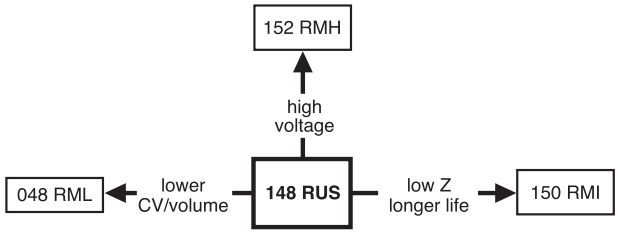


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Miniaturized, ultra high CV-product per unit volume
- Very long useful life: 3000 hours at 105 °C, high reliability
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- EDP, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance value (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (148)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	47 to 22 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	- 40 to + 105 °C
Endurance test at 105 °C:	
case Ø D = 10 mm	1000 hours
case Ø D ≥ 12.5 mm	2000 hours
Useful life at 105 °C:	
case Ø D = 10 mm	2000 hours
case Ø D ≥ 12.5 mm	3000 hours
Useful life at 40 °C, 1.6 x I_R applied:	
case Ø D = 10 mm	140 000 hours
case Ø D ≥ 12.5 mm	200 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)							
	6.3	**10**	**16**	**25**	**35**	**50**	**63**	**100**
47	-	-	-	-	-	-	-	10 x 12
68	-	-	-	-	-	-	-	10 x 16
100	-	-	-	-	-	-	10 x 12	10 x 20
150	-	-	-	-	-	-	-	12.5 x 20
220	-	-	-	-	-	10 x 12	10 x 16	12.5 x 25
	-	-	-	-	-	-	-	16 x 20
330	-	-	-	-	10 x 12	10 x 16	12.5 x 20	16 x 25
470	-	-	-	10 x 12	10 x 16	10 x 20	12.5 x 20	16 x 31
680	-	-	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	-
	-	-	-	-	-	-	16 x 20	-

For technical questions contact: aluminumcaps1@vishay.com
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Revision: 04-Jan-08

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)								
C_R (µF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
1000	-	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	-
	-	-	-	-	-	16 x 20	-	-
1500	-	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	-
	-	-	-	-	16 x 20	-	-	-
2200	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	18 x 35	-
	-	-	-	16 x 20	-	-	-	-
3300	-	12.5 x 20	12.5 x 25	16 x 25	16 x 31	18 x 35	-	-
	-	-	16 x 20	-	-	-	-	-
4700	12.5 x 20	12.5 x 25	16 x 25	16 x 31	18 x 35	-	-	-
	-	16 x 20	-	-	-	-	-	-
6800	16 x 20	16 x 25	16 x 31	18 x 35	-	-	-	-
10 000	16 x 25	16 x 31	18 x 35	-	-	-	-	-
15 000	16 x 31	18 x 35	-	-	-	-	-	-
22 000	18 x 35	-	-	-	-	-	-	-

DIMENSIONS in millimeters, AND AVAILABLE FORMS

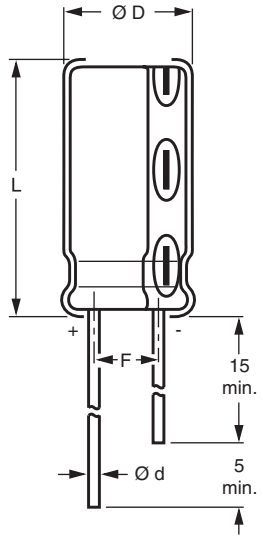


Fig.2 **Form CA**: Long leads

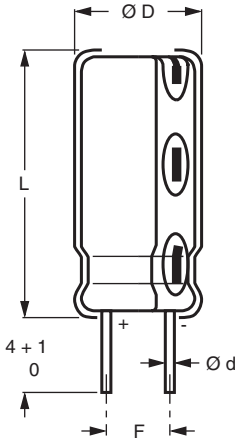


Fig.3 **Form CB**: Cut leads

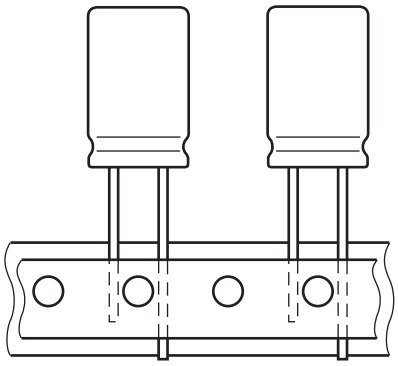


Fig.4 **Form TFA**: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
Nominal CASE SIZE Ø D x L	CASE CODE	Ø d	Ø $D_{max.}$	$L_{max.}$	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	–

Note

Tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 105 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 148 series

470 µF/25 V; ± 20 %

Nominal case size: ∅ 10 × 12 mm; Form TFA

Ordering Code: MAL214836471E3
Former 12NC: 2222 148 36471

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz 20 °C (Ω)	Z 100 kHz - 40 °C (Ω)	ORDERING CODE MAL2148.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
6.3	2200	10 x 16	720	139	0.30	0.170	1.90	53222E3	63222E3	33222E3
	4700	12.5 x 20	1100	296	0.34	0.085	0.60	53472E3	63472E3	33472E3
	6800	16 x 20	1210	428	0.38	0.060	0.30	53682E3	63682E3	33682E3
	10000	16 x 25	1660	630	0.46	0.045	0.25	53103E3	63103E3	33103E3
	15000	16 x 31	2050	945	0.56	0.033	0.15	53153E3	63153E3	33153E3
	22000	18 x 35	2350	1386	0.66	0.032	0.15	53223E3	63223E3	-
10	1000	10 x 12	460	100	0.24	0.240	3.00	54102E3	64102E3	34102E3
	1500	10 x 16	620	150	0.24	0.170	1.90	54152E3	64152E3	34152E3
	2200	10 x 20	750	220	0.26	0.130	1.50	54222E3	64222E3	34222E3
	3300	12.5 x 20	1010	330	0.28	0.085	0.60	54332E3	64332E3	34332E3
	4700	12.5 x 25	1260	470	0.30	0.065	0.50	54472E3	64472E3	34472E3
	4700	16 x 20	1260	470	0.30	0.060	0.30	94475E3	94476E3	94473E3
	6800	16 x 25	1590	680	0.34	0.045	0.25	54682E3	64682E3	34682E3
	10000	16 x 31	1910	1000	0.42	0.033	0.15	54103E3	64103E3	34103E3
	15000	18 x 35	2200	1500	0.52	0.032	0.15	54153E3	64153E3	-
16	680	10 x 12	450	109	0.20	0.240	3.00	55681E3	65681E3	35681E3
	1000	10 x 16	570	160	0.20	0.180	2.00	55102E3	65102E3	35102E3
	1500	10 x 20	720	240	0.20	0.130	1.50	55152E3	65152E3	35152E3
	2200	12.5 x 20	930	352	0.22	0.090	0.60	55222E3	65222E3	35222E3
	3300	12.5 x 25	1180	528	0.24	0.065	0.50	55332E3	65332E3	35332E3
	3300	16 x 20	1120	528	0.24	0.060	0.30	95335E3	95336E3	95333E3
	4700	16 x 25	1480	752	0.26	0.045	0.25	55472E3	65472E3	35472E3
	6800	16 x 31	1790	1088	0.30	0.035	0.20	55682E3	65682E3	35682E3
	10000	18 x 35	2100	1600	0.36	0.032	0.20	55103E3	65103E3	-
25	470	10 x 12	410	118	0.16	0.260	3.20	56471E3	66471E3	36471E3
	680	10 x 16	550	170	0.16	0.190	2.10	56681E3	66681E3	36681E3
	1000	10 x 20	690	250	0.16	0.130	1.50	56102E3	66102E3	36102E3
	1500	12.5 x 20	850	375	0.16	0.100	0.70	56152E3	66152E3	36152E3
	2200	12.5 x 25	1110	550	0.18	0.070	0.50	56222E3	66222E3	36222E3
	2200	16 x 20	1050	550	0.18	0.060	0.30	96225E3	96226E3	96223E3
	3300	16 x 25	1420	825	0.20	0.045	0.25	56332E3	66332E3	36332E3
	4700	16 x 31	1750	1175	0.22	0.035	0.20	56472E3	66472E3	36472E3
	6800	18 x 35	2050	1700	0.26	0.033	0.20	56682E3	66682E3	-

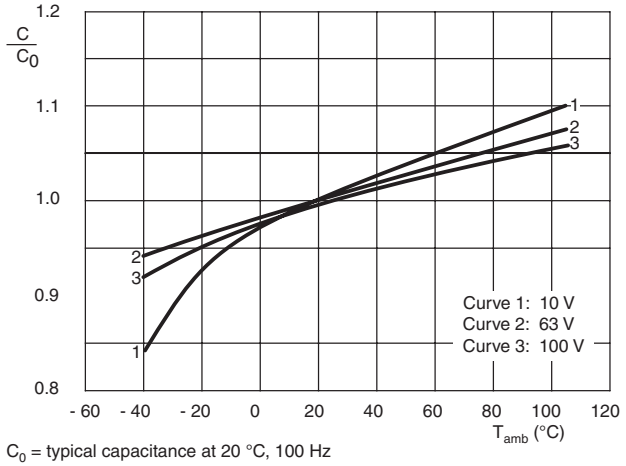
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz 20 °C (Ω)	Z 100 kHz - 40 °C (Ω)	ORDERING CODE MAL2148.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
35	330	10 x 12	350	116	0.14	0.270	3.30	50331E3	60331E3	30331E3
	470	10 x 16	480	165	0.14	0.190	2.10	50471E3	60471E3	30471E3
	680	10 x 20	580	238	0.14	0.140	1.60	50681E3	60681E3	30681E3
	1000	12.5 x 20	810	350	0.14	0.100	0.70	50102E3	60102E3	30102E3
	1500	12.5 x 25	950	525	0.14	0.070	0.50	50152E3	60152E3	30152E3
	1500	16 x 20	970	525	0.14	0.063	0.30	90155E3	90156E3	90153E3
	2200	16 x 25	1270	770	0.16	0.045	0.25	50222E3	60222E3	30222E3
	3300	16 x 31	1620	1155	0.18	0.037	0.20	50332E3	60332E3	30332E3
	4700	18 x 35	1930	1645	0.20	0.033	0.20	50472E3	60472E3	-
50	220	10 x 12	330	110	0.12	0.280	3.40	51221E3	61221E3	31221E3
	330	10 x 16	420	165	0.12	0.200	2.20	51331E3	61331E3	31331E3
	470	10 x 20	530	235	0.12	0.140	1.60	51471E3	61471E3	31471E3
	680	12.5 x 20	720	340	0.12	0.100	0.70	51681E3	61681E3	31681E3
	1000	12.5 x 25	950	500	0.12	0.070	0.50	51102E3	61102E3	31102E3
	1000	16 x 20	880	500	0.12	0.068	0.35	91105E3	91106E3	91103E3
	1500	16 x 25	1180	750	0.12	0.047	0.30	51152E3	61152E3	31152E3
	2200	16 x 31	1520	1100	0.14	0.039	0.20	51222E3	61222E3	31222E3
	3300	18 x 35	1810	1650	0.16	0.035	0.20	51332E3	61332E3	-
63	100	10 x 12	230	63	0.10	0.320	3.90	58101E3	68101E3	38101E3
	220	10 x 16	350	139	0.10	0.240	2.70	58221E3	68221E3	38221E3
	330	12.5 x 20	540	208	0.10	0.130	0.90	58331E3	68331E3	38331E3
	470	12.5 x 20	540	296	0.10	0.130	0.90	58471E3	68471E3	38471E3
	680	12.5 x 25	760	428	0.10	0.085	0.65	58681E3	68681E3	38681E3
	680	16 x 20	820	428	0.10	0.070	0.50	98685E3	98686E3	98683E3
	1000	16 x 25	980	630	0.10	0.049	0.25	58102E3	68102E3	38102E3
	1500	16 x 31	1390	945	0.10	0.042	0.20	58152E3	68152E3	38152E3
	2200	18 x 35	1670	1386	0.12	0.038	0.20	58222E3	68222E3	-
100	47	10 x 12	165	47	0.08	0.640	19.20	59479E3	69479E3	39479E3
	68	10 x 16	190	68	0.08	0.580	17.40	59689E3	69689E3	39689E3
	100	10 x 20	260	100	0.08	0.380	11.40	59101E3	69101E3	39101E3
	150	12.5 x 20	360	150	0.08	0.260	7.80	59151E3	69151E3	39151E3
	220	12.5 x 25	440	220	0.08	0.170	5.10	59221E3	69221E3	39221E3
	220	16 x 20	590	220	0.08	0.140	4.20	99225E3	99226E3	99223E3
	330	16 x 25	630	330	0.08	0.120	3.60	59331E3	69331E3	39331E3
	470	16 x 31	750	470	0.08	0.100	3.00	59471E3	69471E3	39471E3

ADDITIONAL ELECTRICAL DATA

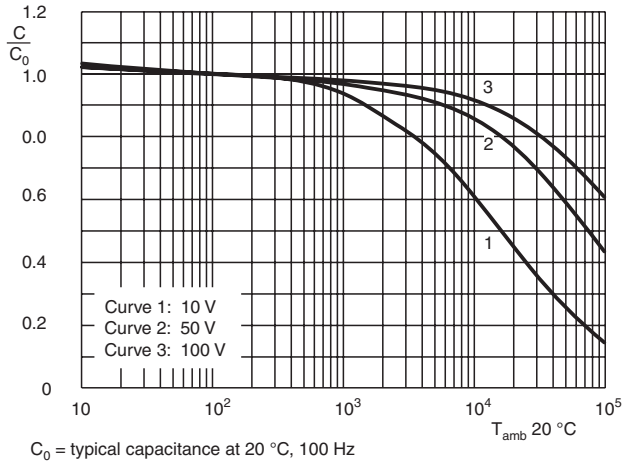
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R$
Inductance		
Equivalent series inductance (ESL)	Case ∅ D = 10 mm	typ. 16 nH
	Case ∅ D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)



C_0 = typical capacitance at 20 °C, 100 Hz

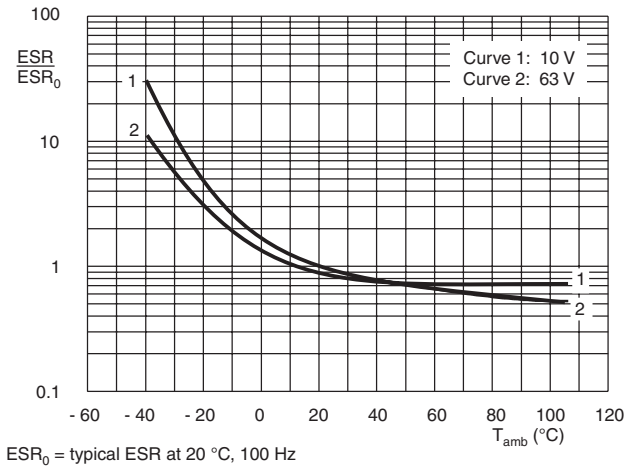
Fig.5 Typical multiplier of capacitance as a function of ambient temperature



C_0 = typical capacitance at 20 °C, 100 Hz

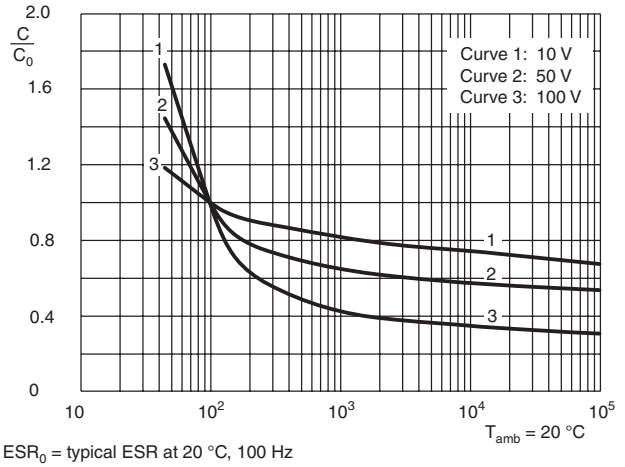
Fig.6 Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)



ESR_0 = typical ESR at 20 °C, 100 Hz

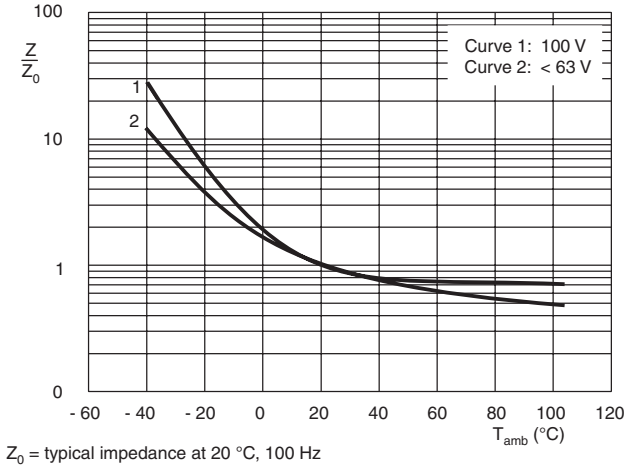
Fig.7 Multiplier of ESR as a function of ambient temperature



ESR_0 = typical ESR at 20 °C, 100 Hz

Fig.8 Multiplier of ESR as a function of frequency

IMPEDANCE (Z)



Z_0 = typical impedance at 20 °C, 100 Hz

Fig.9 Multiplier of impedance as a function of ambient temperature

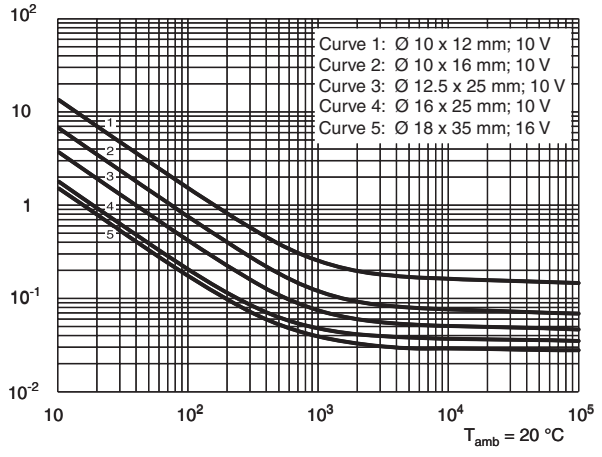


Fig.10 Typical impedance as a function of frequency

IMPEDANCE (Z)

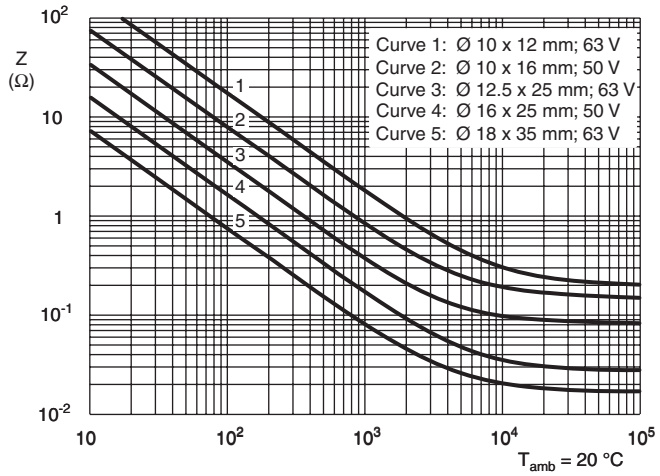


Fig.11 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

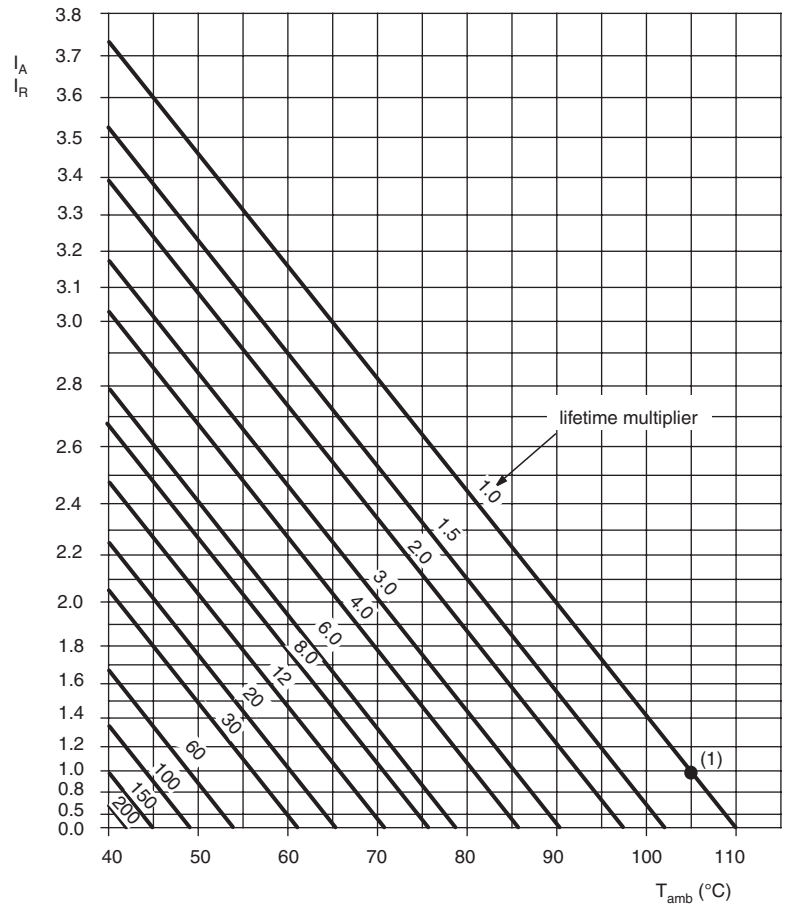


Fig.12 Mulyiplier of useful life as a function of ambient ripple current load

I_A = actual ripple current at 100 Hz

I_R = rated ripple current at 100 Hz, 105 °C

(1) Useful life at 105 °C and I_R applied:
case Ø D = 10 mm: 2000 h
case Ø D ≥ 12.5 mm: 3000 h

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 V	U_R = 50 to 100 V
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥ 10 000	1.20	1.40	1.60

TEST PROCEDURES AND REQUIREMENTS

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied case Ø D = 10 mm: 1000 hours case Ø D ≥ 12.5 mm: 2000 hours	U_R = 6.3 V; ΔC/C: + 15/- 30 % U_R ≥ 10 V; ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied case Ø D = 10 mm: 2000 hours case Ø D ≥ 12.5 mm: 3000 hours	U_R = 6.3 V; ΔC/C: + 45/- 50 % U_R ≥ 10 V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	U_R = 6.3 V; ΔC/C: + 15/- 30 % U_R ≥ 10 V; ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ 2 x spec. limit
Surge	IEC 60384-4/ EN130300 subclause 4.14	from source of 1.15 x U_R: RC = 0.1 ± 0.05 s; 1000 cycles of 30 s on, 330 s off, at 105 °C	ΔC/C: ± 20 % tan δ ≤ 1.5 x spec. limit I_{L5} ≤ spec. limit
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	T_{amb} = 105 °C: 125 h at U = - 1 V, followed by 125 hours at U_R	ΔC/C: ± 15 % tan δ ≤ 1.5 x spec. limit I_{L5} ≤ spec. limit

Aluminum Capacitors
Radial Long Life

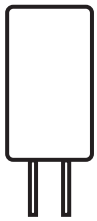
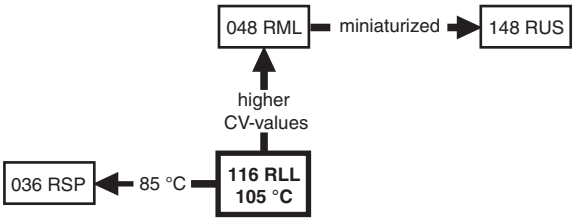


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Long useful life: 2000 h at 105 °C, high reliability
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

- Automotive, telecommunication, industrial and EDP
- Stand-by applications in audio and video equipment
- Coupling, decoupling, timing; smoothing, filtering and buffering in dc-to-dc converters
- Portable and mobile equipment (small size, low mass)

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Minus-sign on top to identify the negative terminal
- Series number (116)

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal Case sizes (Ø D x L in mm)	5 x 11 and 8.2 x 11
Rated capacitance range, C_R	0.47 to 470 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	- 55 to + 105 °C
Endurance test at 105 °C	1500 hours
Endurance test at 85 °C	5000 hours
Useful life at 105 °C	2000 hours
Useful life at 40 °C, 1.3 x I_R applied	200 000 hours
Shelf life at 0 V, 105 °C	1500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)								
	6.3	10	16	25	35	40	50	63	100
0.47	-	-	-	-	-	-	5 x 11	-	-
1.0	-	-	-	-	-	-	5 x 11	-	-
1.5	-	-	-	-	-	-	5 x 11	-	-
2.2	-	-	-	-	-	-	5 x 11	-	-
3.3	-	-	-	-	-	-	5 x 11	-	-
4.7	-	-	-	-	-	-	5 x 11	-	8.2 x 11
6.8	-	-	-	-	-	-	5 x 11	-	-
10	-	-	-	-	-	-	5 x 11	8.2 x 11	8.2 x 11
	-	-	-	-	-	-	8.2 x 11	-	-
15	-	-	-	-	-	-	5 x 11	-	-
22	-	-	-	-	-	-	5 x 11	8.2 x 11	-
	-	-	-	-	-	-	8.2 x 11	-	-
33	-	-	-	-	5 x 11	5 x 11	8.2 x 11	-	-
47	-	-	-	5 x 11	-	-	8.2 x 11	-	-
68	-	-	5 x 11	-	-	-	8.2 x 11	-	-
100	-	5 x 11	-	-	8.2 x 11	8.2 x 11	-	-	-
150	5 x 11	-	-	8.2 x 11	-	-	-	-	-
220	-	-	8.2 x 11	-	-	-	-	-	-
330	-	8.2 x 11	-	-	-	-	-	-	-
470	8.2 x 11	-	-	-	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

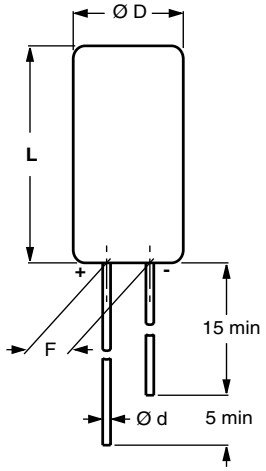
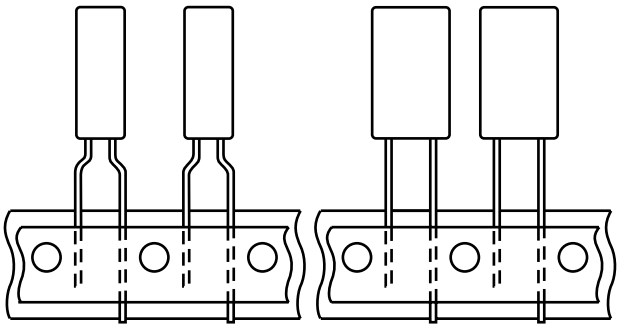
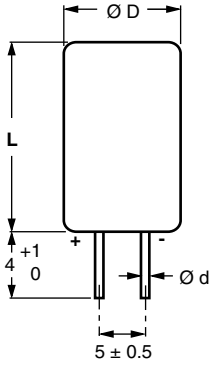


Fig.2 **Form CA:** Long leads



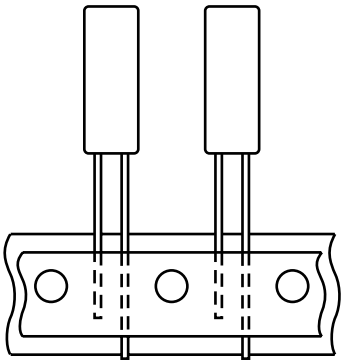
Case Ø D x L = 5 x 11 and 8.2 x 11 mm
Pitch F = 5 mm

Fig.3 **Form TFA**: Taped in box (ammopack)



Case Ø D x L = 8.2 x 11 mm only

Fig.4 **Form CB**: Cut leads



Case Ø D x L = 5 x 11 mm only
Pitch F = 2.5 mm

Fig.5 **Form TNA**: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø D**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**	
							FORM CA, CB	**FORM TFA, TNA**
5 x 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 x 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Note

Tape dimension see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 kHz, 105 °C
I_{L1}	max. leakage current after 1 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz and 20 °C

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 116 series

220 µF/16 V; ± 20 %

Nominal case size: Ø 8.2 x 11 mm; Form TFA

Ordering code: MAL211635221E3
Former 12NC: 2222 116 35221

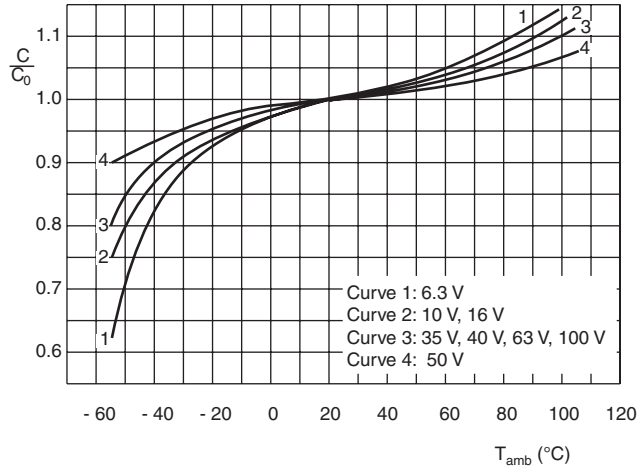
Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L1} 1 min (µA)	tan δ 100 Hz	Z 100 kHz (Ω)	ORDERING CODE MAL2116							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS					
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	150	5 x 11	130	8.7	0.25	1.3	53151E3	2.5	-	-	33151E3	5.0	73151E3	2.5
	470	8.2 x 11	300	21	0.25	0.45	53471E3	5.0	63471E3	5.0	33471E3	5.0	-	-
10	100	5 x 11	130	9	0.2	1.4	54101E3	2.5	-	-	34101E3	5.0	74101E3	2.5
	330	8.2 x 11	280	23	0.2	0.45	54331E3	5.0	64331E3	5.0	34331E3	5.0	-	-
16	68	5 x 11	130	9.5	0.16	1.5	55689E3	2.5	-	-	35689E3	5.0	75689E3	2.5
	220	8.2 x 11	280	24	0.16	0.5	55221E3	5.0	65221E3	5.0	35221E3	5.0	-	-
25	47	5 x 11	120	10	0.14	1.6	56479E3	2.5	-	-	36479E3	5.0	76479E3	2.5
	150	8.2 x 11	260	26	0.14	0.5	56151E3	5.0	66151E3	5.0	36151E3	5.0	-	-
35	33	5 x 11	110	9.9	0.12	1.7	50339E3	2.5	-	-	30339E3	5.0	70339E3	2.5
	100	8.2 x 11	240	24	0.12	0.55	50101E3	5.0	60101E3	5.0	30101E3	5.0	-	-
40	33	5 x 11	110	10.9	0.12	1.7	57339E3	2.5	-	-	37339E3	5.0	77339E3	2.5
	100	8.2 x 11	240	27	0.12	0.55	57101E3	5.0	67101E3	5.0	37101E3	5.0	-	-
50	0.47	5 x 11	30	3.1	0.09	10	51477E3	2.5	-	5.0	31477E3	5.0	71477E3	2.5
	1.0	5 x 11	40	3.3	0.09	6	51108E3	2.5	-	5.0	31108E3	5.0	71108E3	2.5
	1.5	5 x 11	50	3.5	0.09	4	51158E3	2.5	-	5.0	31158E3	5.0	71158E3	2.5
	2.2	5 x 11	60	3.7	0.09	3.5	51228E3	2.5	-	5.0	31228E3	5.0	71228E3	2.5
	3.3	5 x 11	65	4	0.09	3.1	51338E3	2.5	-	5.0	31338E3	5.0	71338E3	2.5
	4.7	5 x 11	70	4.4	0.09	2.8	51478E3	2.5	-	5.0	31478E3	5.0	71478E3	2.5
	6.8	5 x 11	75	5	0.09	2.5	51688E3	2.5	-	5.0	31688E3	5.0	71688E3	2.5
	10	5 x 11	80	6	0.09	2.2	51109E3	2.5	-	5.0	31109E3	5.0	71109E3	2.5
	10	8.2 x 11	160	6	0.05	1.0	90084E3	5.0	90085E3	5.0	90036E3	5.0	-	-
	15	5 x 11	90	7.5	0.09	2.0	51159E3	2.5	-	5.0	31159E3	5.0	71159E3	2.5
	22	5 x 11	110	9.6	0.09	1.9	51229E3	2.5	-	5.0	31229E3	5.0	71229E3	2.5
	22	8.2 x 11	190	9.6	0.06	0.9	90025E3	5.0	90086E3	5.0	90039E3	5.0	-	-
	33	8.2 x 11	190	13	0.09	0.77	51339E3	5.0	61339E3	5.0	31339E3	5.0	-	-
	47	8.2 x 11	210	17	0.09	0.65	51479E3	5.0	61479E3	5.0	31479E3	5.0	-	-
	68	8.2 x 11	240	23	0.09	0.55	51689E3	5.0	61689E3	5.0	31689E3	5.0	-	-
63	10	8.2 x 11	160	7	0.06	1.3	58109E3	5.0	68109E3	5.0	38109E3	5.0	-	-
	22	8.2 x 11	190	11	0.06	0.9	58229E3	5.0	68229E3	5.0	38229E3	5.0	-	-
100	2.2	8.2 x 11	60	4.3	0.06	4	59228E3	5.0	69228E3	5.0	39228E3	5.0	-	-
	4.7	8.2 x 11	75	5.8	0.07	3.5	59478E3	5.0	69478E3	5.0	39478E3	5.0	-	-
	10	8.2 x 11	100	9	0.08	3	59109E3	5.0	69109E3	5.0	39109E3	5.0	-	-

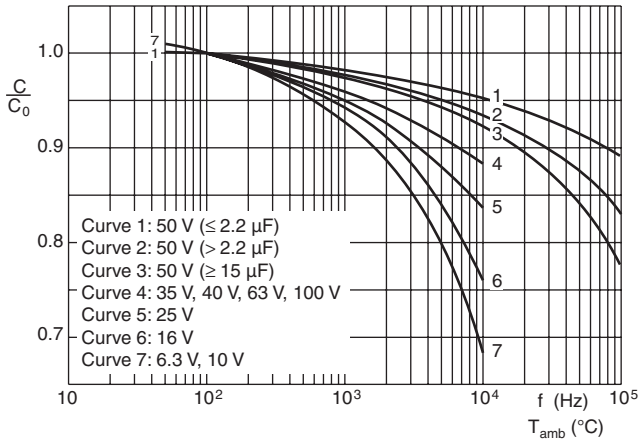
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.3\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minutes at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 3\ \mu A$
	After 5 minutes at U_R	$I_{L5} \leq 0.001\ C_R \times U_R + 3\ \mu A$
Inductance		
Equivalent series inductance (ESL)	Case Ø D x L = 5 x 11 mm	typ. 13 nH
	Case Ø D x L = 8.2 x 11 mm	typ. 16 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)



C_0 = Capacitance at 20 °C, 100 Hz

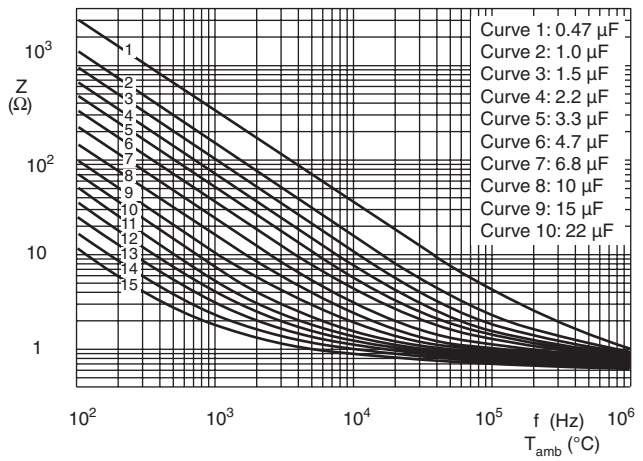
Fig.6 Typical multiplier of capacitance as a function of ambient temperature



C_0 = Capacitance at 20 °C, 100 Hz

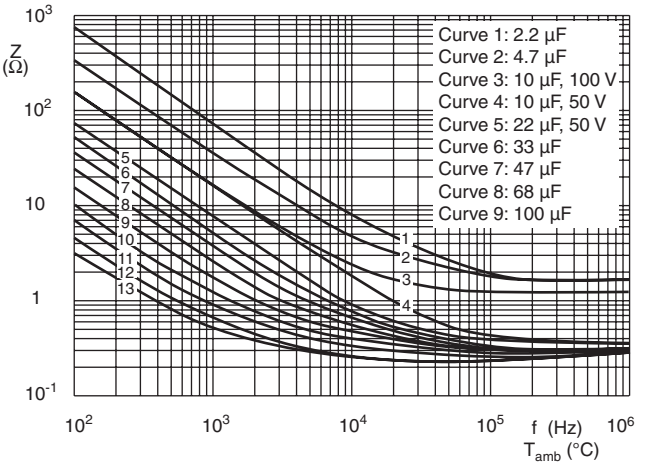
Fig.7 Typical multiplier of capacitance as a function of ambient frequency

IMPEDANCE (Z)



Case Ø D x L = 5 x 11 mm

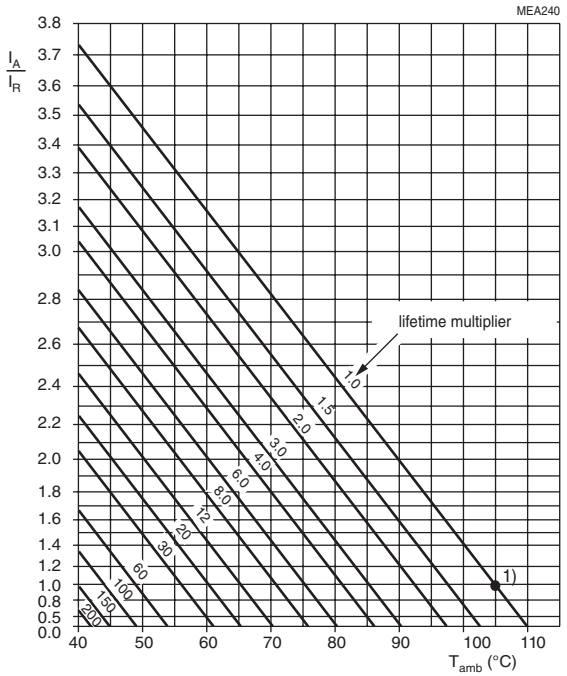
Fig.8 Typical impedance as a function of frequency



Case Ø D x L = 8.2 x 11 mm

Fig.9 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C
(1) = useful life at 105 °C and I_R applied: 2000 h

Fig.10 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 35 V	U_R = 40 to 100 V ($C_R \geq 10$ µF)
50	0.70	0.60	0.50
100	0.77	0.71	0.63
300	0.86	0.85	0.78
1000	0.92	0.93	0.88
3000	0.96	0.96	0.94
10 to 100 k	1.00	1.00	1.00

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; 1500 h	$U_R \leq 6.3$ V; ΔC/C: + 15/- 30 % $U_R > 6.3$ V; ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 2000 h	$U_R \leq 6.3$ V; ΔC/C: + 45/- 50 % $U_R > 6.3$ V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1%
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1500 h after test: U_R to be applied for 30 min, 24 to 48 h before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_{L5} ≤ 2 x spec. limit

Aluminum Capacitors
Radial Miniature Long Life

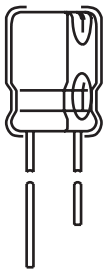
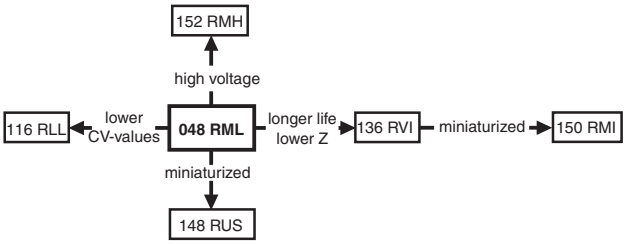


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Very long useful life: 3000 to 4000 hours at 105 °C, high reliability
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

- EDP, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (048)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	100 to 10 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	- 40 to + 105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C case Ø D = 10 and 12.5 mm case Ø D = 16 and 18 mm	 3000 hours 4000 hours
Useful life at 40 °C, 1.6 x I_R applied case Ø D = 10 and 12.5 mm case Ø D = 16 and 18 mm	 200 000 hours 260 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)							
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**
100	-	-	-	-	-	-	-	10 x 12
220	-	-	-	-	10 x 12	-	10 x 16	10 x 20
330	-	-	-	-	-	-	-	12.5 x 20
470	-	-	10 x 12	10 x 16	10 x 20	-	12.5 x 20	12.5 x 25
1000	-	10 x 16	10 x 20	12.5 x 20	12.5 x 25	-	16 x 25	16 x 31
2200	-	12.5 x 20	12.5 x 25	16 x 25	16 x 31	16 x 35	18 x 35	18 x 35
3300	-	12.5 x 25	16 x 25	16 x 31	18 x 35	18 x 35	18 x 35	-
4700	-	16 x 25	16 x 31	18 x 35	18 x 35	-	-	-
6800	16 x 25	16 x 31	16 x 35	-	-	-	-	-
10 000	16 x 35	18 x 35	18 x 35	-	-	-	-	-

DIMENSIONS in millimeters, **AND AVAILABLE FORMS**

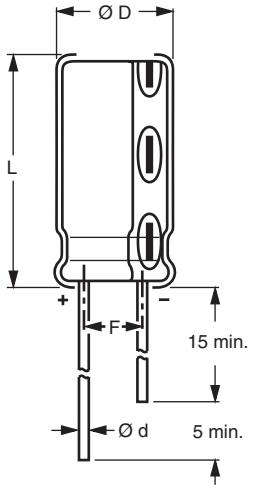


Fig.2 **Form CA**: Long leads

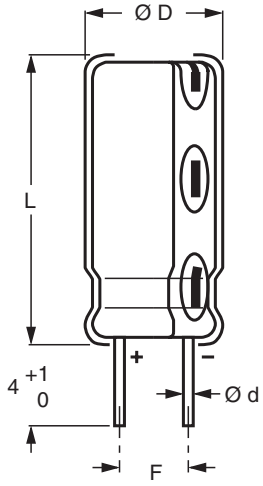


Fig.3 **Form CB**: Cut leads

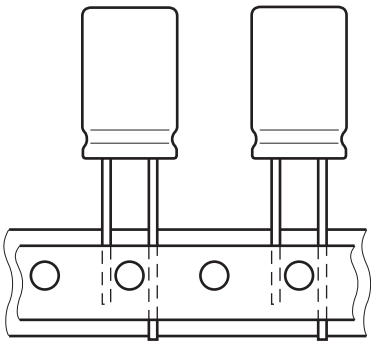


Fig.4 **Form TFA**: Taped in box (ammopack)

Table 1

DIMENSIONS IN MILLIMETERS, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø $D_{max.}$	$L_{max.}$	F	MASS (g)	PACKAGING QUANTITIES		
							Form CA	Form CB	Form TFA
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.5	100	100	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	-

Note

Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 105 °C
I_{L1}	max. leakage current after 1 minute at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 048 series

2200 µF/16 V; ± 20 %

Nominal case size: Ø 12.5 x 25 mm; Form TFA

Ordering code: MAL204835222E3
Former 12NC: 2222 048 35222

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	DIMENSIONS Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	tan δ 100 Hz	Z 100 kHz (mΩ)	ORDERING NUMBER MAL2048.....		
							BULK PACKAGING		TAPED
							Form CA	Form CB	Form TFA
6.3	6800	16 x 25	1350	430	0.32	56	53682E3	63682E3	33682E3
	10 000	16 x 35	1700	630	0.40	42	53103E3	63103E3	-
10	1000	10 x 16	470	100	0.19	180	54102E3	64102E3	34102E3
	2200	12.5 x 20	800	220	0.21	90	54222E3	64222E3	34222E3
	3300	12.5 x 25	1000	330	0.23	68	54332E3	64332E3	34332E3
	4700	16 x 25	1270	470	0.25	56	54472E3	64472E3	34472E3
	6800	16 x 31	1550	680	0.29	45	54682E3	64682E3	34682E3
	10 000	18 x 35	1870	1000	0.37	36	54103E3	64103E3	-
16	470	10 x 12	360	78	0.16	250	55471E3	65471E3	35471E3
	1000	10 x 20	600	160	0.16	140	55102E3	65102E3	35102E3
	2200	12.5 x 25	1000	360	0.18	70	55222E3	65222E3	35222E3
	3300	16 x 25	1220	530	0.20	56	55332E3	65332E3	35332E3
	4700	16 x 31	1500	760	0.22	45	55472E3	65472E3	35472E3
	6800	16 x 35	1690	1100	0.26	42	55682E3	65682E3	-
	10 000	18 x 35	1980	1600	0.34	34	55103E3	65103E3	-
25	470	10 x 16	440	120	0.14	180	56471E3	66471E3	36471E3
	1000	12.5 x 20	720	250	0.14	100	56102E3	66102E3	36102E3
	2200	16 x 25	1120	550	0.16	56	56222E3	66222E3	36222E3
	3300	16 x 31	1450	830	0.18	45	56332E3	66332E3	36332E3
	4700	18 x 35	1720	1200	0.20	36	56472E3	66472E3	-
35	220	10 x 12	310	80	0.12	280	50221E3	60221E3	30221E3
	470	10 x 20	500	170	0.12	150	50471E3	60471E3	30471E3
	1000	12.5 x 25	900	350	0.12	75	50102E3	60102E3	30102E3
	2200	16 x 31	1340	770	0.14	45	50222E3	60222E3	30222E3
	3300	18 x 35	1600	1200	0.16	36	50332E3	60332E3	-
	4700	18 x 35	1950	1600	0.18	34	50472E3	60472E3	-
40	2200	16 x 35	1500	880	0.13	45	57222E3	67222E3	-
	3300	18 x 35	1600	1300	0.15	36	57332E3	67332E3	-
50	220	10 x 16	340	110	0.10	250	51221E3	61221E3	31221E3
	470	12.5 x 20	620	240	0.10	110	51471E3	61471E3	31471E3
	1000	16 x 25	1030	500	0.10	60	51102E3	61102E3	31102E3
	2200	18 x 35	1500	1100	0.12	50	51222E3	61222E3	-
	3300	18 x 35	1900	1700	0.14	40	51332E3	61332E3	-
63	100	10 x 12	240	66	0.09	310	58101E3	68101E3	38101E3
	220	10 x 20	400	140	0.09	200	58221E3	68221E3	38221E3
	330	12.5 x 20	550	210	0.09	120	58331E3	68331E3	38331E3
	470	12.5 x 25	700	300	0.09	80	58471E3	68471E3	38471E3
	1000	16 x 31	1150	630	0.09	49	58102E3	68102E3	38102E3
	2200	18 x 35	1600	1400	0.11	45	58222E3	68222E3	-

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.01\ C_R \times U_R + 3\ \mu A$
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 10 mm	typ. 16 nH
	Case Ø D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)

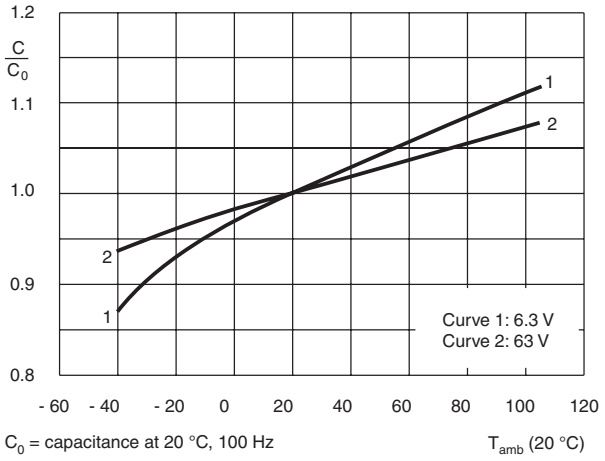


Fig.5 Typical multiplier of capacitance as a function of ambient temperature

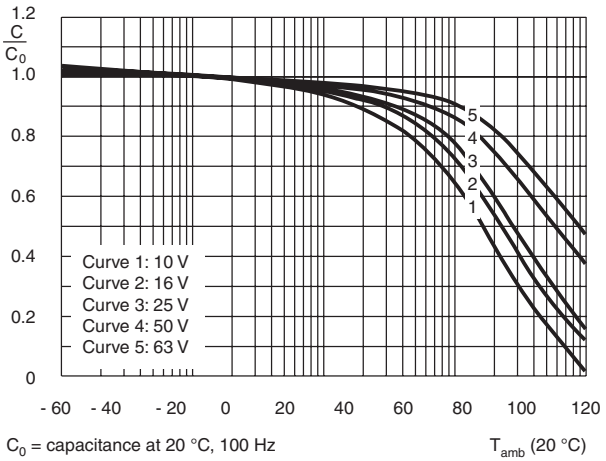


Fig.6 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

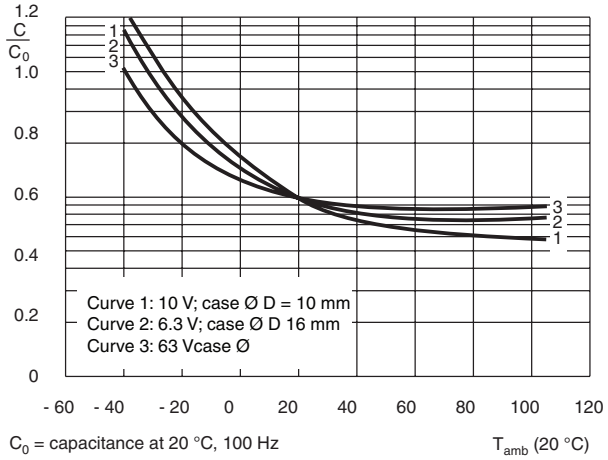


Fig.7 Typical multiplier of ESR as a function of ambient temperature

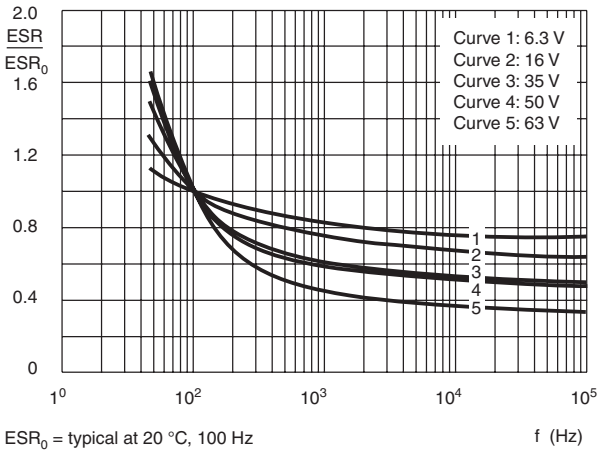


Fig.8 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

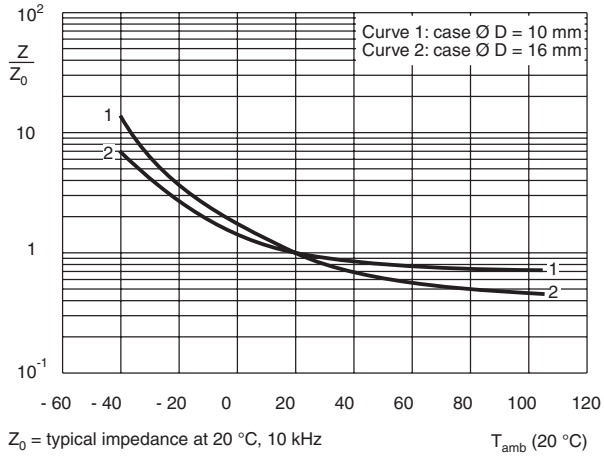


Fig.9 Typical multiplier of impedance as a function of ambient temperature

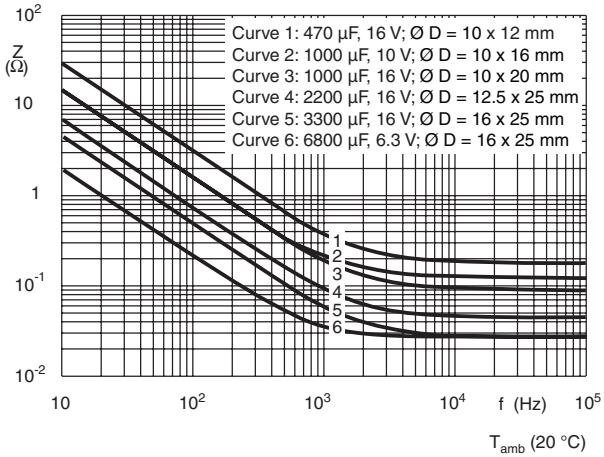


Fig.10 Typical impedance as a function of frequency

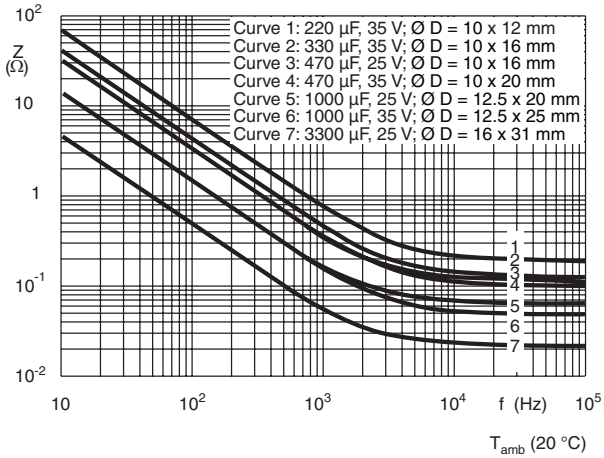


Fig.11 Typical impedance as a function of frequency

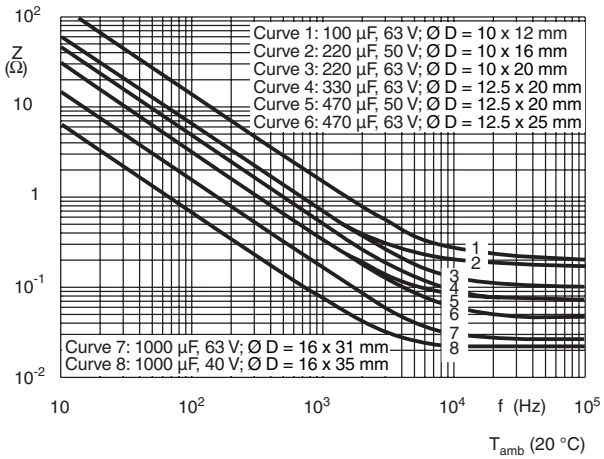
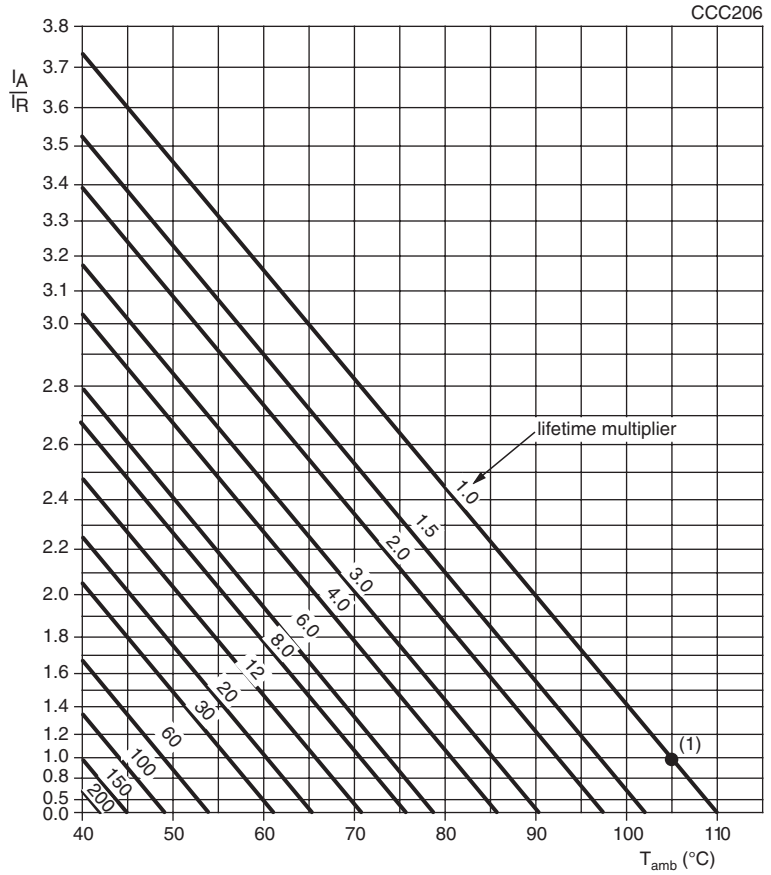


Fig.12 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C
(1) Useful life at 105 °C and I_R applied (see table 4)

Fig.13 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥ 10 000	1.20	1.40	1.60

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; 2000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: + 15/- 30 % $U_R > 6.3$ V; $\Delta C/C$: ± 15 % tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; case Ø D = 10 and 12.5 mm: 3000 hours case Ø D = 16 and 18 mm: 4000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: + 45/- 50 % $U_R > 6.3$ V; $\Delta C/C$: ± 45 % tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$U_R \leq 6.3$ V; $\Delta C/C$: + 15/- 30 % $U_R > 6.3$ V; $\Delta C/C$: ± 15 % tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

Aluminum Capacitors
Radial Miniature, High Voltage

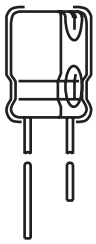
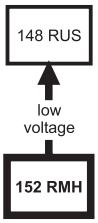


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue vinyl sleeve
- Pressure relief
- Charge and discharge proof
- Miniaturized, ultra high CV-product per unit volume
- Long useful life:
  3000 to 4000 h at 105 °C, high reliability
- Lead (Pb)-Free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- High-reliability and professional applications
- Lighting, monitors, consumer electronics, general industrial
- Filtering of high voltages in power supplies

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance value (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (152)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	1.0 to 220 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	200 to 450 V
Category temperature range	- 40 to + 105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C:	
Case Ø D = 10 and 12.5 mm	3000 hours
Case Ø D = 16 and 18 mm	4000 hours
Useful life at 40 °C, 1.6 x I_R applied:	
Case Ø D = 10 and 12.5 mm	200 000 hours
Case Ø D = 16 and 18 mm	260 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN 130300
Climatic category IEC 60068	40/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)			
	200	**250**	**400**	**450**
1.0	-	-	-	10 x 12
2.2	-	-	10 x 12	10 x 16
4.7	-	-	10 x 16	10 x 20
	-	-	10 x 12	-
6.8	-	-	10 x 16	12.5 x 20
10	10 x 12	10 x 16	10 x 20	12.5 x 20
22	10 x 16	12.5 x 20	12.5 x 25	16 x 25
	-	-	16 x 20	18 x 20
33	10 x 20	12.5 x 20	16 x 20	16 x 35
	-	-	-	18 x 25
47	12.5 x 20	12.5 x 25	16 x 25	18 x 35
	-	16 x 20	-	-
68	12.5 x 25	-	16 x 35	-
100	16 x 20	16 x 25	18 x 35	-
220	16 x 35	-	-	-

DIMENSIONS in millimeters, **AVAILABLE FORMS**

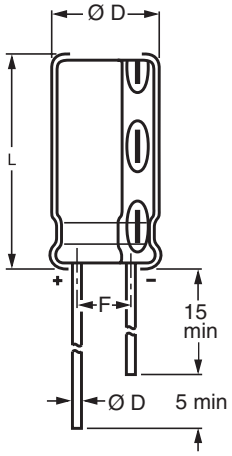


Fig.2 **Form CA**: Long leads

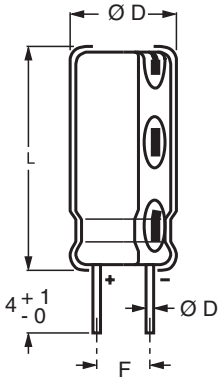


Fig.3 **Form CB**: Cut leads

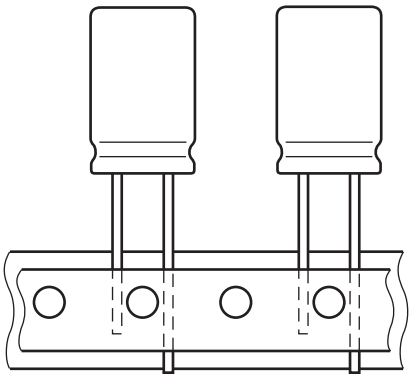


Fig.4 **Form TFA**: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø D**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**		
							FORM CA	**FORM CB**	**FORM TFA**
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	-
18 x 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	-
18 x 25	1825	0.8	18.5	27.0	7.5 ± 0.5	≈ 10.0	100	100	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	-

Note

Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 105 °C
I_{L1}	max. leakage current after 1 minute at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 152 series
4.7 µF/400 V; ± 20 %
Nominal case size: Ø 10 x 16 mm; Form TFA

Ordering Code: MAL215236478E3
Former 12NC: 2222 152 36478

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

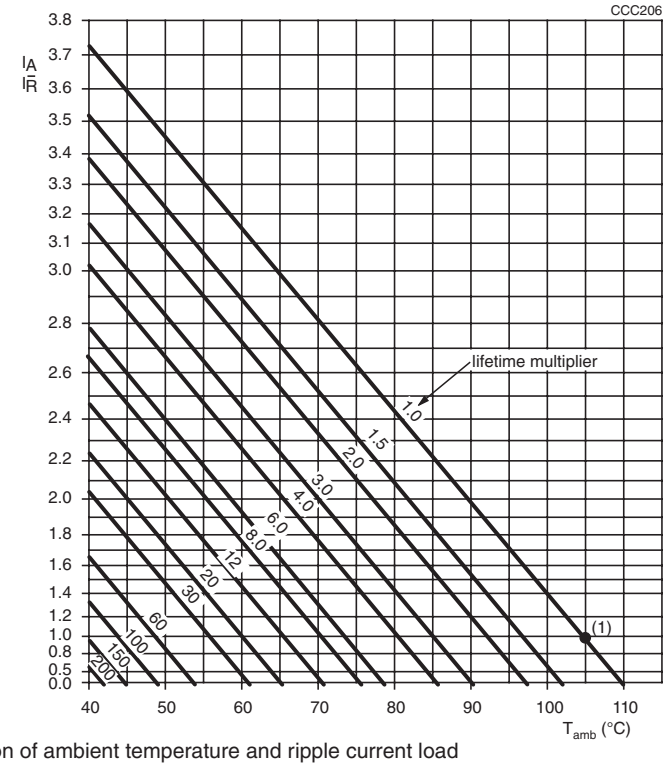
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2152		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
200	10	10 x 12	85	130	0.12	6.3	52109E3	62109E3	32109E3
	22	10 x 16	120	202	0.12	3.2	52229E3	62229E3	32229E3
	33	10 x 20	150	268	0.12	2.3	52339E3	62339E3	32339E3
	47	12.5 x 20	240	352	0.12	0.9	52479E3	62479E3	32479E3
	68	12.5 x 25	310	478	0.12	0.6	52689E3	62689E3	32689E3
	100	16 x 20	340	670	0.12	0.4	52101E3	62101E3	32101E3
	220	16 x 35	630	1390	0.12	0.2	52221E3	62221E3	-
250	10	10 x 16	105	145	0.12	6.3	53109E3	63109E3	33109E3
	22	12.5 x 20	180	235	0.12	2.3	53229E3	63229E3	33229E3
	33	12.5 x 20	180	318	0.12	1.5	53339E3	63339E3	33339E3
	47	12.5 x 25	310	423	0.12	0.9	53479E3	63479E3	33479E3
	47	16 x 20	310	423	0.12	0.9	93475E3	93476E3	93473E3
	100	16 x 25	340	820	0.12	0.4	53101E3	63101E3	33101E3
400	2.2	10 x 12	44	96	0.15	28.0	56228E3	66228E3	36228E3
	4.7	10 x 12	48	127	0.15	24.0	96475E3	96476E3	96473E3
	4.7	10 x 16	65	126	0.15	18.0	56478E3	66478E3	36478E3
	6.8	10 x 16	65	152	0.15	12.0	56688E3	66688E3	36688E3
	10	10 x 20	80	190	0.15	9.0	56109E3	66109E3	36109E3
	22	12.5 x 25	150	334	0.15	3.8	56229E3	66229E3	36229E3
	22	16 x 20	150	334	0.15	3.8	96225E3	96226E3	96223E3
	33	16 x 20	190	466	0.15	2.6	56339E3	66339E3	36339E3
	47	16 x 25	240	634	0.15	2.0	56479E3	66479E3	36479E3
	68	16 x 35	310	886	0.15	1.7	56689E3	66689E3	-
	100	18 x 35	380	1270	0.15	0.9	56101E3	66101E3	-
450	1.0	10 x 12	30	67	0.20	94.0	57108E3	67108E3	37108E3
	2.2	10 x 16	50	99	0.20	26.0	57228E3	67228E3	37228E3
	4.7	10 x 20	65	133	0.20	20.0	57478E3	67478E3	37478E3
	6.8	12.5 x 20	80	162	0.20	16.0	57688E3	67688E3	37688E3
	10	12.5 x 20	90	205	0.20	10.0	57109E3	67109E3	37109E3
	22	16 x 25	150	367	0.20	4.6	57229E3	67229E3	37229E3
	22	18 x 20	150	367	0.20	4.6	97225E3	97226E3	-
	33	16 x 35	200	516	0.20	3.4	57339E3	67339E3	-
	33	18 x 25	200	516	0.20	3.4	97335E3	97336E3	-
	47	18 x 35	260	705	0.20	2.0	57479E3	67479E3	-

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage	U_R = 200 to 250 V	$U_s \leq 1.15 \times U_R$
	U_R = 400 to 450 V	$U_s \leq 1.10 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.03\ C_R \times U_R + 70\ \mu A$
	After 5 minutes at U_R	$I_{L5} \leq 0.015\ C_R \times U_R + 30\ \mu A$
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 10 mm	typ. 16 nH
	Case Ø D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R)		
FREQUENCY (Hz)	**I_R MULTIPLIER**	
	$U_R \leq 250$ V	**$U_R > 250$ V**
50	0.75	0.75
100	1.00	1.00
300	1.50	1.30
1000	2.00	1.60
3000	2.20	1.90
10 000	2.50	2.20
≥ 100 000	3.00	2.50

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz

I_R = rated ripple current at 100 Hz, 105 °C

(1) Useful life at 105 °C and I_R applied
case Ø D = 10 and 12.5: 3000 h
case Ø D = 16 and 18: 4000 h

Fig.5 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; 2000 h	$\Delta C/C$: ± 20 % tan $\delta \leq 2$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; case Ø D = 10 and 12.5: 3000 h case Ø D = 16 and 18: 4000 h	$\Delta C/C$: ± 50 % tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 h after test: U_R to be applied for 30 min, 24 to 48 h before measurement	$\Delta C/C$: ± 20 % tan $\delta \leq 2$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq 2$ x spec. limit
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	T_{amb} = 105 °C: 125 h at U = - 1 V, followed by 125 h at U_R	$\Delta C/C$: ± 15 % $I_{L5} \leq$ spec. limit tan $\delta \leq$ spec. limit

Aluminum Capacitors
Radial Very Low Impedance

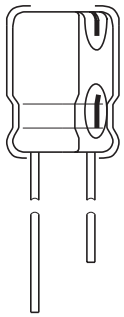
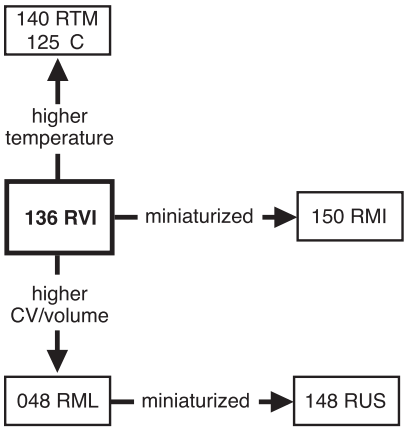


Fig.1 Component outline



QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	22 to 10 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, C_R	10 to 100 V
Category temperature range	- 55 to + 105 °C
Endurance test at 105 °C	3000 to 5000 hours (dependent on case size)
Useful life at 105 °C	4000 to 10 000 hours (dependent on case size)
Useful life at 40 °C, 1.8 x I_R applied	200 000 to 500 000 hours (dependent on case size)
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/105/56

FEATURES

Pb-free

RoHS COMPLIANT

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Very long useful life: 4000 to 10 000 hours at 105 °C, very high reliability
- Very low impedance or ESR respectively,
- Excellent ripple current capability
- Lead (Pb)-free versions are RoHS compliant

APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, automotive and telecommunications
- Smoothing, filtering, buffering

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance value (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (136)

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
C_R (µF)	U_R (V)						
	10	**16**	**25**	**35**	**50**	**63**	**100**
22	-	-	-	-	-	-	10 x 12
33	-	-	-	-	-	-	10 x 12
47	-	-	-	-	-	10 x 12	10 x 16
56	-	-	-	-	-	10 x 12	-
68	-	-	-	-	-	10 x 16	10 x 20
82	-	-	-	-	10 x 12	-	-
100	-	-	-	-	10 x 12	10 x 16	12.5 x 20
120	-	-	-	10 x 12	10 x 16	10 x 20	-
	-	-	-	-	-	12.5 x 16	-
150	-	-	-	10 x 12	10 x 20	10 x 25	16 x 20
180	-	-	10 x 12	-	10 x 20	10 x 30	-
	-	-	-	-	12.5 x 16	-	-
220	-	-	10 x 12	10 x 16	10 x 25	12.5 x 20	16 x 25
270	-	10 x 12	-	-	-	12.5 x 25	-
330	-	10 x 12	10 x 16	10 x 20	10 x 30	16 x 20	16 x 31
	-	-	-	12.5 x 16	12.5 x 20	-	-
390	10 x 12	-	-	10 x 25	-	12.5 x 31	-
470	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 35
	-	-	12.5 x 16	-	-	-	18 x 31
560	-	-	10 x 25	10 x 30	12.5 x 31	-	-
	-	-	-	12.5 x 20	-	-	-
680	10 x 16	10 x 20	-	12.5 x 25	16 x 20	16 x 31	18 x 35
	-	12.5 x 16	-	-	-	18 x 25	-
820	-	10 x 25	10 x 30	-	16 x 25	16 x 35	-
	-	-	12.5 x 20	-	-	-	-
1000	10 x 20	12.5 x 20	12.5 x 25	12.5 x 31	16 x 31	18 x 31	-
	12.5 x 16	-	-	16 x 20	18 x 20	-	-
1200	10 x 25	10 x 30	-	16 x 25	16 x 35	-	-
	-	12.5 x 20	-	-	-	-	-
1500	10 x 30	12.5 x 25	12.5 x 31	16 x 25	18 x 31	18 x 35	-
	12.5 x 20	-	16 x 20	-	-	-	-
1800	12.5 x 20	-	16 x 25	16 x 31	-	-	-
2200	12.5 x 25	12.5 x 31	16 x 31	16 x 35	18 x 35	-	-
	-	16 x 20	18 x 20	18 x 31	-	-	-
2700	12.5 x 31	16 x 25	16 x 31	-	-	-	-
3300	16 x 20	16 x 25	16 x 35	18 x 35	-	-	-
	-	-	18 x 31	-	-	-	-
3900	16 x 25	16 x 31	-	-	-	-	-
4700	16 x 31	16 x 35	18 x 35	-	-	-	-
	-	18 x 31	-	-	-	-	-
5600	16 x 31	-	-	-	-	-	-
	18 x 25	-	-	-	-	-	-
6800	16 x 35	18 x 35	-	-	-	-	-
	18 x 31	-	-	-	-	-	-
10 000	18 x 35	-	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

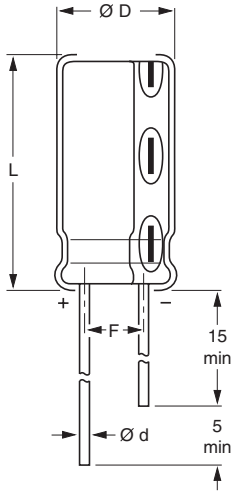


Fig.2 **Form CA**: Long leads

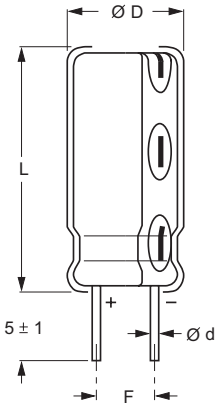


Fig.3 **Form CB**: Cut leads

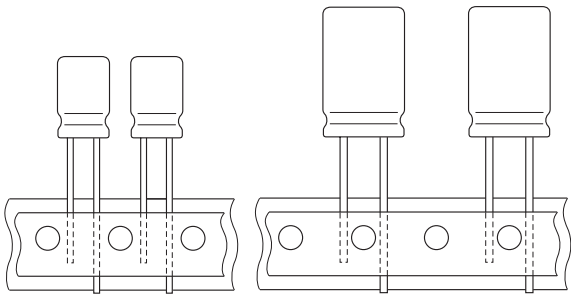


Fig.4 **Form TFA**: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**		
							FORM CA	**FORM CB**	**FORM TFA**
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
10 x 25	16L	0.6	10.5	27.0	5.0 ± 0.5	≈ 3.0	1000	1500	800
10 x 30	16LL	0.6	10.5	32.0	5.0 ± 0.5	≈ 3.5	1000	750	-
12.5 x 16	17a	0.6	13.0	17.5	5.0 ± 0.5	≈ 2.7	1000	1500	500
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
12.5 x 31	18L	0.6	13.0	33.5	5.0 ± 0.5	≈ 5.5	1000	750	-
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	-
18 x 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	-
18 x 25	1825	0.8	18.5	27.0	7.5 ± 0.5	≈ 10.0	100	100	-
18 x 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	-

Note

Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 kHz, 105 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 136 series

1000 µF725 V; ± 20 %

Nominal case size: Ø 12.5 x 25 mm; Form TFA

Ordering code: MAL213636102E3
Former 12NC: 2222 136 36102

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz + 20 °C (mΩ)	Z 100 kHz - 10 °C (mΩ)	ORDERING CODE MAL2136.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
10	390	10 x 12	630	39	0.19	120	240	54391E3	64391E3	34391E3
	470	10 x 12	630	47	0.19	120	240	54471E3	64471E3	34471E3
	680	10 x 16	830	68	0.19	84	170	54681E3	64681E3	34681E3
	1000	10 x 20	1000	100	0.19	62	130	54102E3	64102E3	34102E3
	1000	12.5 x 16	940	100	0.19	76	160	94105E3	94106E3	94103E3
	1200	10 x 25	1300	120	0.19	52	110	54122E3	64122E3	34122E3
	1500	10 x 30	1400	150	0.19	44	88	94155E3	94156E3	-
	1500	12.5 x 20	1300	150	0.19	46	92	54152E3	64152E3	34152E3
	1800	12.5 x 20	1340	180	0.19	46	92	54182E3	64182E3	34182E3
	2200	12.5 x 25	1700	220	0.21	34	68	54222E3	64222E3	34222E3
	2700	12.5 x 31	2000	270	0.21	30	60	54272E3	64272E3	-
	3300	16 x 20	1600	330	0.23	38	76	54332E3	64332E3	34332E3
	3900	16 x 25	2100	390	0.23	28	56	54392E3	64392E3	34392E3
	4700	16 x 31	2400	470	0.25	25	50	54472E3	64472E3	34472E3
	5600	16 x 31	2400	560	0.27	25	50	54562E3	64562E3	34562E3
	5600	18 x 25	2270	560	0.27	25	50	94565E3	94566E3	-
	6800	16 x 35	2600	680	0.29	22	44	54682E3	64682E3	-
	6800	18 x 31	2760	680	0.29	23	46	94685E3	94686E3	-
	10 000	18 x 35	3180	1000	0.31	21	42	54103E3	64103E3	-
16	270	10 x 12	630	43	0.16	120	240	55271E3	65271E3	35271E3
	330	10 x 12	630	53	0.16	120	240	55331E3	65331E3	35331E3
	470	10 x 16	830	75	0.16	84	170	55471E3	65471E3	35471E3
	680	10 x 20	1000	110	0.16	62	130	55681E3	65681E3	35681E3
	680	12.5 x 16	940	110	0.16	76	160	95685E3	95686E3	95683E3
	820	10 x 25	1300	130	0.16	52	110	55821E3	65821E3	35821E3
	1000	12.5 x 20	1300	160	0.16	48	96	55102E3	65102E3	35102E3
	1200	10 x 30	1400	190	0.16	44	88	95125E3	95126E3	-
	1200	12.5 x 20	1300	190	0.16	46	92	55122E3	65122E3	35122E3
	1500	12.5 x 25	1700	240	0.16	34	68	55152E3	65152E3	35152E3
	2200	12.5 x 31	2000	350	0.18	30	60	95225E3	95226E3	-
	2200	16 x 20	1600	350	0.18	38	76	55222E3	65222E3	35222E3
	2700	16 x 25	2100	430	0.18	28	56	55272E3	65272E3	35272E3
	3300	16 x 25	2100	530	0.20	28	56	55332E3	65332E3	35332E3
	3900	16 x 31	2400	620	0.20	25	50	55392E3	65392E3	35392E3
	4700	16 x 35	2600	750	0.22	22	44	55472E3	65472E3	-
	4700	18 x 31	2560	750	0.22	23	46	95475E3	95476E3	-
	6800	18 x 35	3000	1090	0.24	21	42	55682E3	65682E3	-

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz + 20 °C (mΩ)	Z 100 kHz - 10 °C (mΩ)	ORDERING CODE MAL2136.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
25	180	10 x 12	630	45	0.14	120	240	56181E3	66181E3	36181E3
	220	10 x 12	630	55	0.14	120	240	56221E3	66221E3	36221E3
	330	10 x 16	830	83	0.14	84	170	56331E3	66331E3	36331E3
	470	10 x 20	1000	120	0.14	62	130	56471E3	66471E3	36471E3
	470	12.5 x 16	940	120	0.14	76	160	96475E3	96476E3	96473E3
	560	10 x 25	1300	140	0.14	52	110	56561E3	66561E3	36561E3
	820	10 x 30	1400	210	0.14	44	88	96825E3	96826E3	-
	820	12.5 x 20	1300	210	0.14	46	92	56821E3	66821E3	36821E3
	1000	12.5 x 25	1700	250	0.14	34	68	56102E3	66102E3	36102E3
	1500	12.5 x 31	2000	380	0.14	30	60	96155E3	96156E3	-
	1500	16 x 20	1700	380	0.14	38	76	56152E3	66152E3	36152E3
	1800	16 x 25	2100	450	0.14	28	56	56182E3	66182E3	36182E3
	2200	16 x 31	2400	550	0.16	25	50	56222E3	66222E3	36222E3
	2200	18 x 20	1680	550	0.16	28	56	96225E3	96226E3	-
	2700	16 x 31	2400	680	0.16	25	50	56272E3	66272E3	36272E3
	3300	16 x 35	2600	830	0.18	22	44	56332E3	66332E3	-
	3300	18 x 31	2490	830	0.18	27	54	96335E3	96336E3	-
	4700	18 x 35	3000	1180	0.20	21	42	56472E3	66472E3	-
35	120	10 x 12	630	42	0.12	120	240	50121E3	60121E3	30121E3
	150	10 x 12	630	53	0.12	120	240	50151E3	60151E3	30151E3
	220	10 x 16	830	77	0.12	84	170	50221E3	60221E3	30221E3
	330	10 x 20	1000	120	0.12	62	130	50331E3	60331E3	30331E3
	330	12.5 x 16	940	120	0.12	76	160	90335E3	90336E3	90333E3
	390	10 x 25	1300	140	0.12	52	110	50391E3	60391E3	30391E3
	470	12.5 x 20	1300	170	0.12	48	96	50471E3	60471E3	30471E3
	560	10 x 30	1400	200	0.12	44	88	90565E3	90566E3	-
	560	12.5 x 20	1300	200	0.12	46	92	50561E3	60561E3	30561E3
	680	12.5 x 25	1700	240	0.12	34	68	50681E3	60681E3	30681E3
	1000	12.5 x 31	2000	350	0.12	30	60	90105E3	90106E3	-
	1000	16 x 20	1700	350	0.12	38	76	50102E3	60102E3	30102E3
	1200	16 x 25	2100	420	0.12	28	56	50122E3	60122E3	30122E3
	1500	16 x 25	2100	530	0.12	28	56	50152E3	60152E3	30152E3
	1800	16 x 31	2400	630	0.12	25	50	50182E3	60182E3	30182E3
	2200	16 x 35	2600	770	0.14	22	44	50222E3	60222E3	-
	2200	18 x 31	2320	770	0.14	27	54	90225E3	90226E3	-
	3300	18 x 35	2890	1160	0.16	21	42	50332E3	60332E3	-
50	82	10 x 12	480	41	0.10	200	400	51829E3	61829E3	31829E3
	100	10 x 12	480	50	0.10	200	400	51101E3	61101E3	31101E3
	120	10 x 16	760	60	0.10	100	200	51121E3	61121E3	31121E3
	150	10 x 20	850	75	0.10	90	180	51151E3	61151E3	31151E3
	180	10 x 20	950	90	0.10	75	150	51181E3	61181E3	31181E3
	180	12.5 x 16	780	90	0.10	59	120	91185E3	91186E3	91183E3
	220	10 x 25	1200	110	0.10	63	130	51221E3	61221E3	31221E3
	330	10 x 30	1300	170	0.10	54	110	91335E3	91336E3	-
	330	12.5 x 20	1200	170	0.10	59	120	51331E3	61331E3	31331E3
	470	12.5 x 25	1500	240	0.10	44	88	51471E3	61471E3	31471E3
	560	12.5 x 31	1700	280	0.10	39	78	51561E3	61561E3	-
	680	16 x 20	1400	340	0.10	50	100	51681E3	61681E3	31681E3
	820	16 x 25	1900	410	0.10	34	68	51821E3	61821E3	31821E3
	1000	16 x 31	2200	500	0.10	30	60	51102E3	61102E3	31102E3
	1000	18 x 20	1510	500	0.10	41	82	91105E3	91106E3	-
	1200	16 x 35	2300	600	0.10	27	54	51122E3	61122E3	-
	1500	18 x 31	2200	750	0.10	31	62	51152E3	61152E3	-
	2200	18 x 35	2650	1100	0.12	27	54	51222E3	61222E3	-

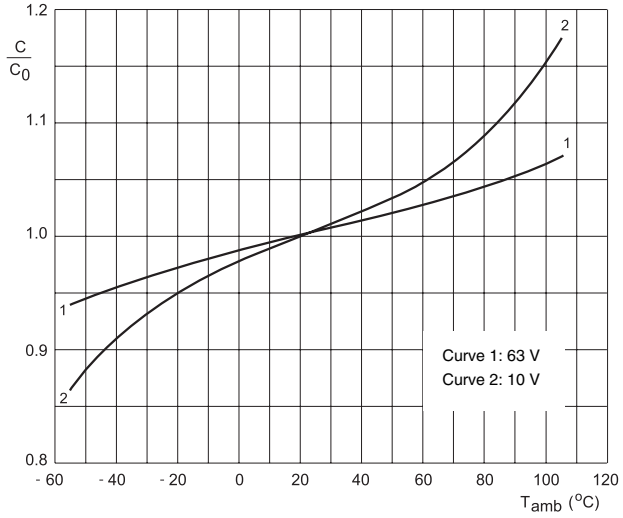
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz + 20 °C (mΩ)	Z 100 kHz - 10 °C (mΩ)	ORDERING CODE MAL2136.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
63	47	10 x 12	380	30	0.10	300	750	58479E3	68479E3	38479E3
	56	10 x 12	420	35	0.10	270	680	58569E3	68569E3	38569E3
	68	10 x 16	520	43	0.10	210	530	58689E3	68689E3	38689E3
	100	10 x 16	580	63	0.10	190	480	58101E3	68101E3	38101E3
	120	10 x 20	650	76	0.10	160	400	58121E3	68121E3	38121E3
	120	12.5 x 16	610	76	0.10	180	450	98125E3	98126E3	98123E3
	150	10 x 25	780	95	0.10	130	330	58151E3	68151E3	38151E3
	180	10 x 30	960	110	0.10	100	250	58181E3	68181E3	-
	220	12.5 x 20	870	140	0.10	110	280	58221E3	68221E3	38221E3
	270	12.5 x 25	1200	170	0.10	74	190	58271E3	68271E3	38271E3
	330	16 x 20	1100	210	0.10	85	220	58331E3	68331E3	38331E3
	390	12.5 x 31	1300	250	0.10	68	170	58391E3	68391E3	-
	470	16 x 25	1500	300	0.10	55	140	58471E3	68471E3	38471E3
	680	16 x 31	1700	430	0.10	46	120	58681E3	68681E3	38681E3
	680	18 x 25	1470	430	0.10	54	108	98685E3	98686E3	-
	820	16 x 35	1900	520	0.10	40	100	58821E3	68821E3	-
	1000	18 x 31	1950	630	0.10	39	78	58102E3	68102E3	-
	1500	18 x 35	2350	950	0.10	33	66	58152E3	68152E3	-
100	22	10 x 12	300	22	0.07	450	2300	59229E3	69229E3	39229E3
	33	10 x 12	320	33	0.07	390	2000	59339E3	69339E3	39339E3
	47	10 x 16	450	47	0.07	320	1600	59479E3	69479E3	39479E3
	68	10 x 20	520	68	0.07	240	1200	59689E3	69689E3	39689E3
	100	12.5 x 20	800	100	0.07	150	750	59101E3	69101E3	39101E3
	150	16 x 20	1000	150	0.07	110	550	59151E3	69151E3	39151E3
	220	16 x 25	1300	220	0.07	81	400	59221E3	69221E3	39221E3
	330	16 x 31	1600	330	0.07	58	290	59331E3	69331E3	39331E3
	470	16 x 35	1800	470	0.07	45	230	59471E3	69471E3	-
	470	18 x 31	1800	470	0.07	45	230	99475E3	99476E3	-
	680	18 x 35	2000	680	0.07	39	200	59681E3	69681E3	-

ADDITIONAL ELECTRICAL DATA

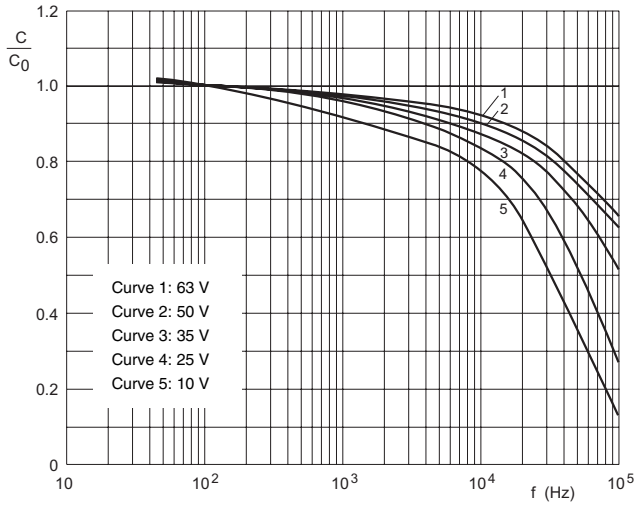
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 10 mm	typ. 16 nH
	Case Ø D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)



C_0 = typical capacitance at 20 °C, 100 Hz

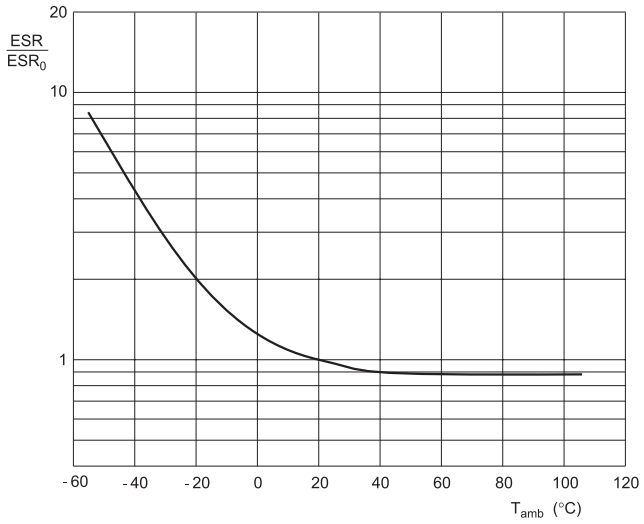
Fig.5 Typical multiplier of capacitance as a function of ambient temperature



C_0 = typical capacitance at 20 °C, 100 Hz T_{amb} = 20 °C

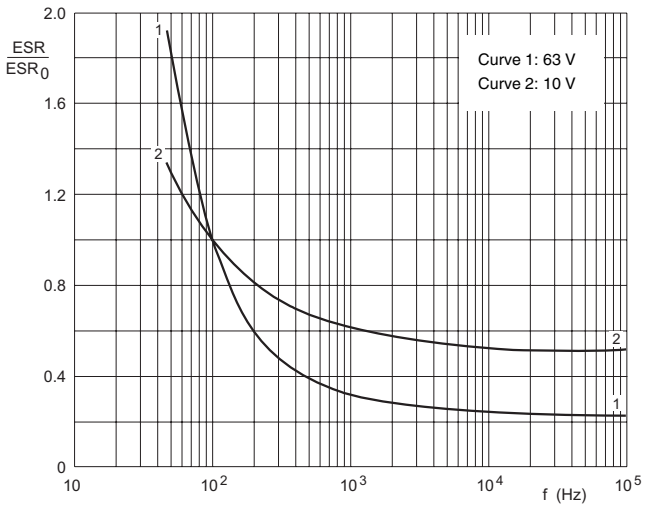
Fig.6 Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)



ESR_0 = typical ESR at 20 °C, 100 Hz

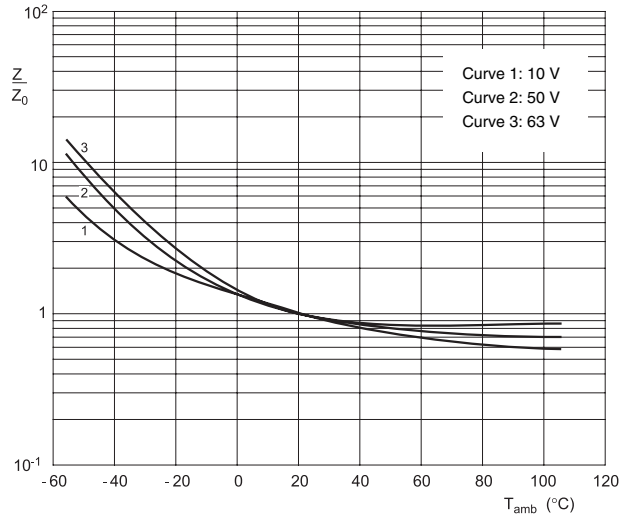
Fig.7 Typical multiplier of ESR as a function of ambient temperature



ESR_0 = typical ESR at 20 °C, 100 Hz T_{amb} = 20 °C.

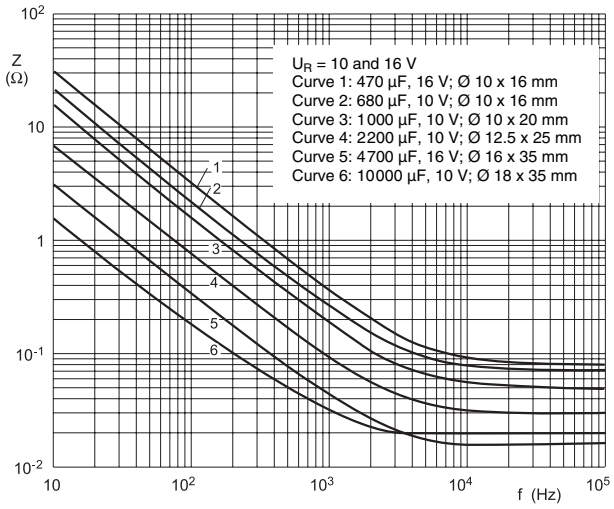
Fig.8 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)



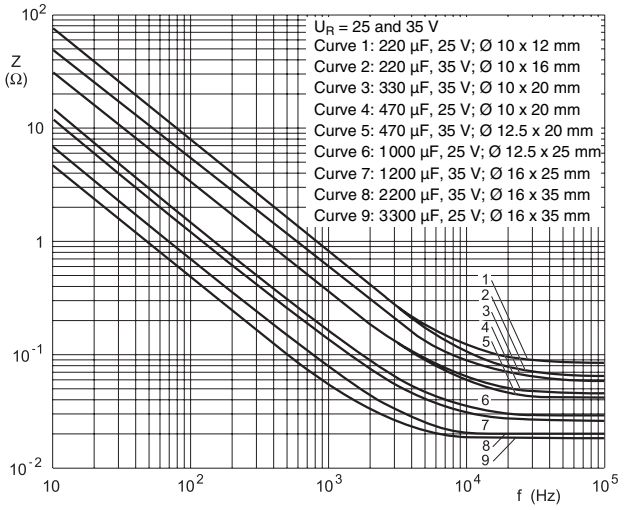
Z_0 = typical impedance at 20 °C, 100 kHz

Fig.9 Typical multiplier of impedance as a function of ambient temperature



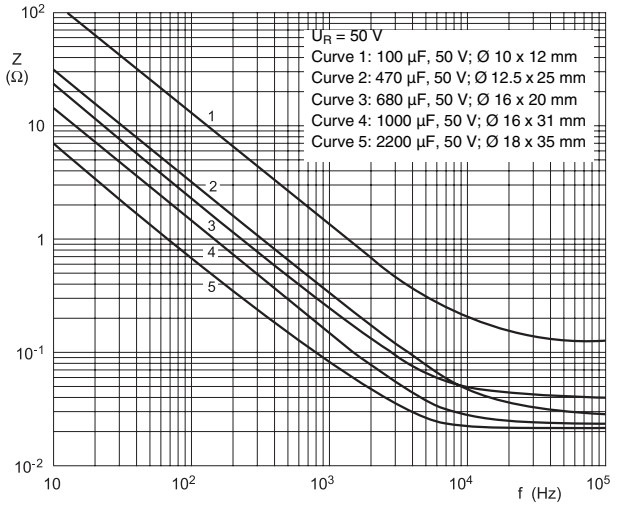
T_{amb} = 20 °C

Fig.10 Typical impedance as a function of frequency



T_{amb} = 20 °C

Fig.11 Typical impedance as a function of frequency



T_{amb} = 20 °C

Fig.12 Typical impedance as a function of frequency

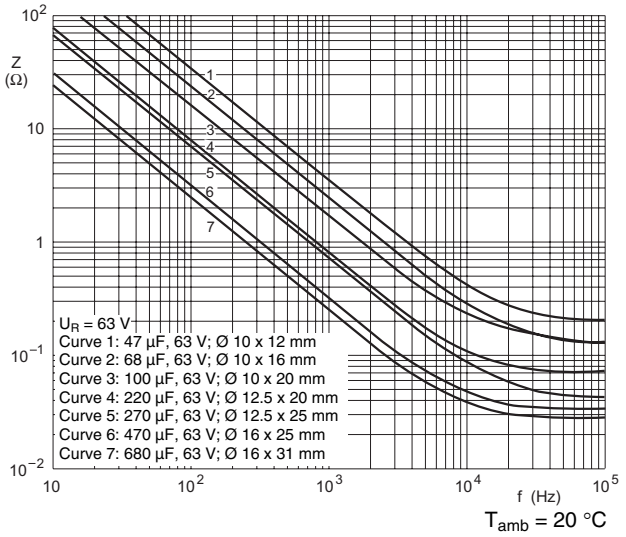
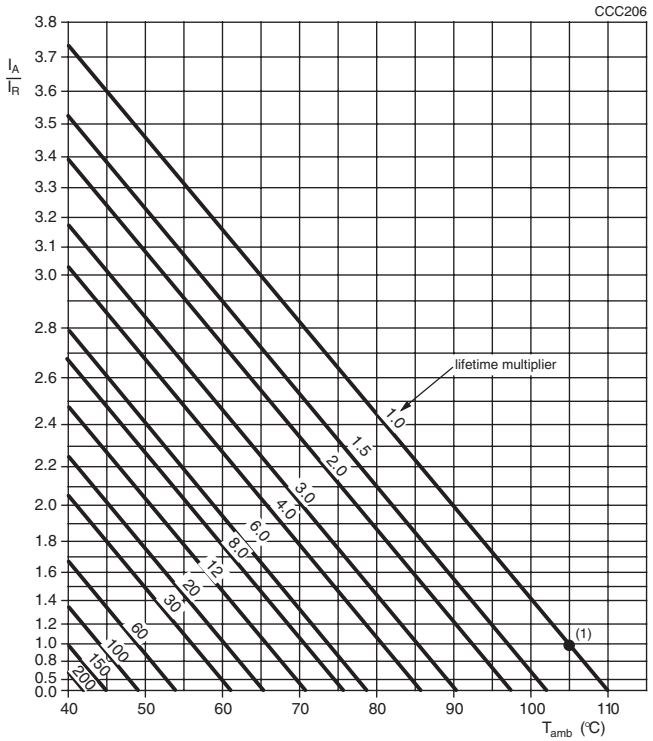


Fig.13 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

Table 3

ENDURANCE TEST AND USEFUL LIFE AS A FUNCTION OF CASE SIZE			
NOMINAL CASE SIZE Ø D x L (mm)	**CASE CODE**	**ENDURANCE TEST AT 105 °C (h)**	**USEFUL LIFE AT 105 °C (h)**
10 x 12	14	3000	4000
10 x 16	15	3000	6000
10 x 20	16	3000	6000
10 x 25	16L	5000	7000
10 x 30	16LL	5000	7000
12.5 x 16	17a	3000	5000
12.5 x 20	17	3000	7000
12.5 x 25	18	5000	8000
12.5 x 31	18L	5000	8000
16 x 20	19a	3000	7000
16 x 25	19	5000	10 000
16 x 31	20	5000	10 000
16 x 35	21	5000	10 000
18 x 20	1820	3000	7000
18 x 25	1825	5000	10 000
18 x 31	1831	5000	10 000
18 x 35	22	5000	10 000



I_A = actual ripple current at 100 kHz

I_R = rated ripple current at 100 kHz, 105 °C

(1) Useful life at 105 °C and I_R applied; see Table 3

Fig.14 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY								
FREQUENCY (Hz)	I_R MULTIPLIER							
	U_R = 10 V		U_R = 16 and 25 V		U_R = 35 and 50 V		U_R = 63 and 100 V	
	Ø ≤ 12.5	Ø ≥ 16	Ø ≤ 12.5	Ø ≥ 16	Ø ≤ 12.5	Ø ≥ 16	Ø ≤ 12.5	Ø ≥ 16
100	0.70	0.83	0.63	0.69	0.50	0.60	0.35	0.50
300	0.80	0.90	0.72	0.79	0.61	0.71	0.51	0.64
1000	0.88	0.95	0.80	0.87	0.72	0.80	0.66	0.74
3000	0.92	0.98	0.88	0.92	0.81	0.88	0.76	0.83
10 000	0.96	0.99	0.92	0.96	0.88	0.93	0.85	0.90
30 000	0.99	1.00	0.98	0.99	0.94	0.96	0.92	0.95
100 000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (QUICK REFERENCE)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; for test duration see Table 3	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; for test duration see Table 3	ΔC/C: ± 30 % tan δ ≤ 3 x spec. limit I_{L2} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit

Aluminum Capacitors
Radial Miniature, Low Impedance

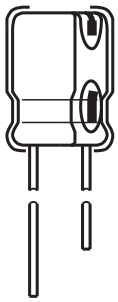
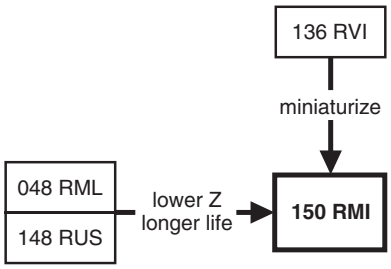


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Very long useful life:
  4000 to 10 000 h at 105 °C, high stability, high reliability
- Very low impedance or ESR respectively, at smaller case sizes than the 136 RVI series
- Excellent ripple current capability
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS
COMPLIANT

APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, automotive and telecommunications
- Smoothing, filtering, buffering

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin.
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (150)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	8 x 12 to 18 x 31
Rated capacitance range, C_R	100 to 6800 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	10 to 100 V
Category temperature range	- 55 to + 105 °C
Endurance test at 105 °C	3000 to 5000 hours
Useful life at 105 °C	4000 to 10 000 hours
Useful life at 40 °C, 1.8 x I_R applied	200 000 to 500 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)						
	10	**16**	**25**	**35**	**50**	**63**	**100**
22	-	-	-	-	-	-	8 x 12
47	-	-	-	-	-	8 x 12	-
100	-	-	-	8 x 12	-	10 x 12	-
150	-	-	-	-	10 x 12	10 x 16	-
220	-	8 x 12	8 x 12	8 x 15	10 x 16	10 x 20	-
	-	-	-	10 x 12	-	-	-
330	-	8 x 12	10 x 12	10 x 16	10 x 20	12.5 x 20	18 x 20
470	8 x 12	8 x 15	10 x 16	10 x 20	12.5 x 20	12.5 x 25	-
	-	10 x 12	-	-	-	16 x 20	-
680	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 20	-
	-	-	-	-	-	16 x 25	-
1000	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	-
	-	-	-	16 x 20	-	-	-
1200	-	-	-	-	16 x 31	-	-

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
C_R (µF)	U_R (V)						
	10	**16**	**25**	**35**	**50**	**63**	**100**
1500	-	12.5 x 20	12.5 x 25	16 x 20	16 x 31	-	-
	-	-	-	12.5 x 35	-	-	-
2200	12.5 x 20	12.5 x 25	16 x 20	16 x 31	-	-	-
	-	-	12.5 x 35	-	-	-	-
3300	12.5 x 25	16 x 20	16 x 31	18 x 31	-	-	-
4700	16 x 25	16 x 31	16 x 35	-	-	-	-
6800	16 x 31	16 x 35	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

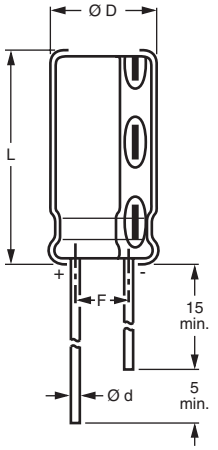


Fig.2 **Form CA**: Long leads

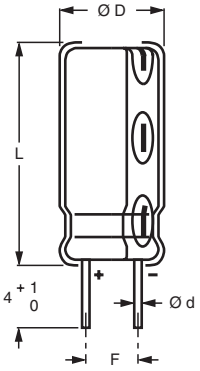
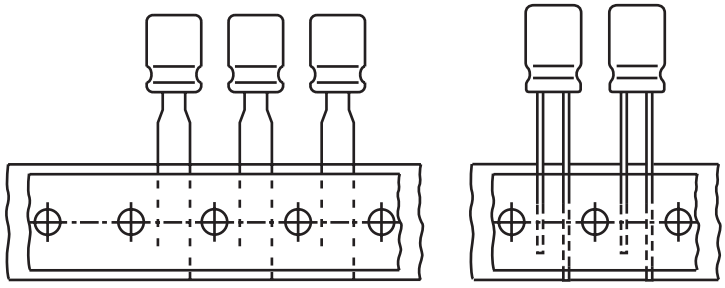


Fig.3 **Form CB**: Cut leads



Formed leads for Ø D = 8 mm with pitch F = 5 mm

Fig.4 **Form TFA**: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**		
							FORM CA	**FORM CB**	**FORM TFA**
8 x 12	13	0.6	8.5	13.0	3.5 ± 0.5	≈ 1.1	5000	5000	1000
8 x 15	13L	0.6	8.5	16.0	3.5 ± 0.5	≈ 1.3	5000	5000	1000
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
12.5 x 35	18LL	0.6	13.0	37.5	5.0 ± 0.5	≈ 6.0	250	250	-
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	-
18 x 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	-
18 x 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	-

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz , tolerance ± 20 %
I_R	rated RMS ripple current at 100 kHz , 105 °C
I_{L2}	max. leakage current after 2 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 150 series

470 µF/16 V; ± 20 %

Nominal case size: Ø 10 x 12 mm; Form TFA

Ordering Code: MAL215035471E3
Former 12NC: 2222 150 35471

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz + 20 °C (Ω)	Z 100 kHz - 40 °C (Ω)	ORDERING CODE MAL2150.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
10	470	8 x 12	555	47	0.19	0.117	0.870	54471E3	84471E3	34471E3
	680	10 x 12	730	71	0.19	0.097	0.680	54681E3	64681E3	34681E3
	1000	10 x 16	950	103	0.19	0.066	0.460	54102E3	64102E3	34102E3
	2200	12.5 x 20	1460	223	0.21	0.037	0.260	54222E3	64222E3	34222E3
	3300	12.5 x 25	1950	333	0.21	0.029	0.200	54332E3	64332E3	34332E3
	4700	16 x 25	2390	473	0.23	0.022	0.150	54472E3	64472E3	34472E3
	6800	16 x 31	2890	683	0.25	0.019	0.130	54682E3	64682E3	34682E3
16	220	8 x 12	555	35	0.16	0.117	0.870	55221E3	85221E3	35221E3
	330	8 x 12	555	53	0.16	0.117	0.870	55331E3	85331E3	35331E3
	470	8 x 15	730	78	0.16	0.085	0.750	95475E3	95478E3	95473E3
	470	10 x 12	730	78	0.16	0.097	0.680	55471E3	65471E3	35471E3
	680	10 x 16	950	112	0.16	0.066	0.460	55681E3	65681E3	35681E3
	1000	10 x 20	1180	163	0.16	0.049	0.340	55102E3	65102E3	35102E3
	1500	12.5 x 20	1460	243	0.16	0.037	0.260	55152E3	65152E3	35152E3
	2200	12.5 x 25	1950	355	0.18	0.029	0.200	55222E3	65222E3	35222E3
	3300	16 x 20	1840	531	0.20	0.028	0.200	55332E3	65332E3	35332E3
	4700	16 x 31	2890	755	0.22	0.019	0.130	55472E3	65472E3	35472E3
	6800	16 x 35	3100	1091	0.24	0.018	0.130	55682E3	65682E3	-
25	220	8 x 12	555	55	0.14	0.117	0.870	56221E3	86221E3	36221E3
	330	10 x 12	730	86	0.14	0.097	0.680	56331E3	66331E3	36331E3
	470	10 x 16	950	121	0.14	0.066	0.460	56471E3	66471E3	36471E3
	680	10 x 20	1180	173	0.14	0.049	0.340	56681E3	66681E3	36681E3
	1000	12.5 x 20	1460	253	0.14	0.037	0.260	56102E3	66102E3	36102E3
	1500	12.5 x 25	1950	378	0.14	0.029	0.200	56152E3	66152E3	36152E3
	2200	12.5 x 35	2510	553	0.16	0.028	0.200	96225E3	96226E3	-
	2200	16 x 20	1840	553	0.16	0.028	0.200	56222E3	66222E3	36222E3
	3300	16 x 31	2890	828	0.16	0.019	0.130	56332E3	66332E3	36332E3
	4700	16 x 35	3100	1178	0.18	0.018	0.130	56472E3	66472E3	-
35	100	8 x 12	555	35	0.12	0.117	0.870	50101E3	80101E3	30101E3
	220	8 x 15	730	77	0.12	0.085	0.750	90225E3	90228E3	90223E3
	220	10 x 12	730	80	0.12	0.097	0.680	50221E3	60221E3	30221E3
	330	10 x 16	950	118	0.12	0.066	0.460	50331E3	60331E3	30331E3
	470	10 x 20	1180	167	0.12	0.049	0.340	50471E3	60471E3	30471E3
	680	12.5 x 20	1460	241	0.12	0.037	0.260	50681E3	60681E3	30681E3
	1000	12.5 x 25	1950	353	0.12	0.029	0.200	50102E3	60102E3	30102E3
	1000	16 x 20	1840	353	0.12	0.028	0.200	90105E3	90106E3	90103E3
	1500	12.5 x 35	2510	528	0.12	0.028	0.200	90186E3	90187E3	-
	1500	16 x 20	1840	528	0.12	0.028	0.200	50152E3	60152E3	30152E3
	2200	16 x 31	2890	773	0.14	0.019	0.130	50222E3	60222E3	30222E3
	3300	18 x 31	3000	1155	0.16	0.019	0.130	50332E3	60332E3	-
50	150	10 x 12	500	78	0.10	0.200	1.400	51151E3	61151E3	31151E3
	220	10 x 16	700	113	0.10	0.120	0.840	51221E3	61221E3	31221E3
	330	10 x 20	900	168	0.10	0.090	0.630	51331E3	61331E3	31331E3
	470	12.5 x 20	1100	238	0.10	0.062	0.430	51471E3	61471E3	31471E3
	680	12.5 x 25	1400	343	0.10	0.048	0.340	51681E3	61681E3	31681E3
	1000	16 x 25	1800	503	0.10	0.034	0.240	51102E3	61102E3	31102E3
	1200	16 x 31	2200	603	0.10	0.027	0.190	51122E3	61122E3	31122E3
	1500	16 x 31	2200	753	0.10	0.027	0.190	51152E3	61152E3	31152E3

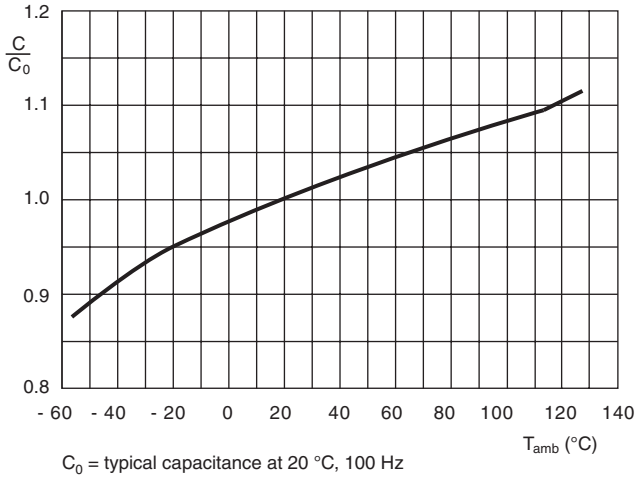
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz + 20 °C (Ω)	Z 100 kHz - 40 °C (Ω)	ORDERING CODE MAL2150.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
63	47	8 x 12	405	30	0.09	0.342	2.350	58479E3	88479E3	38479E3
	100	10 x 12	420	66	0.10	0.270	1.890	58101E3	68101E3	38101E3
	150	10 x 16	560	97	0.10	0.190	1.330	58151E3	68151E3	38151E3
	220	10 x 20	700	141	0.10	0.150	1.050	58221E3	68221E3	38221E3
	330	12.5 x 20	930	211	0.10	0.095	0.670	58331E3	68331E3	38331E3
	470	12.5 x 25	1200	299	0.10	0.067	0.470	58471E3	68471E3	38471E3
	470	16 x 20	1100	299	0.10	0.074	0.520	98475E3	98476E3	98473E3
	680	16 x 20	1100	431	0.10	0.074	0.520	58681E3	68681E3	38681E3
	680	16 x 25	1500	431	0.10	0.054	0.380	98685E3	98686E3	98683E3
	1000	16 x 31	1900	633	0.10	0.042	0.295	58102E3	68102E3	38102E3
100	22	8 x 12	230	22	0.08	0.68	27.0	59229E3	89229E3	39229E3
	330	18 x 20	1700	330	0.07	0.074	2.0	90183E3	90185E3	-

ADDITIONAL ELECTRICAL DATA

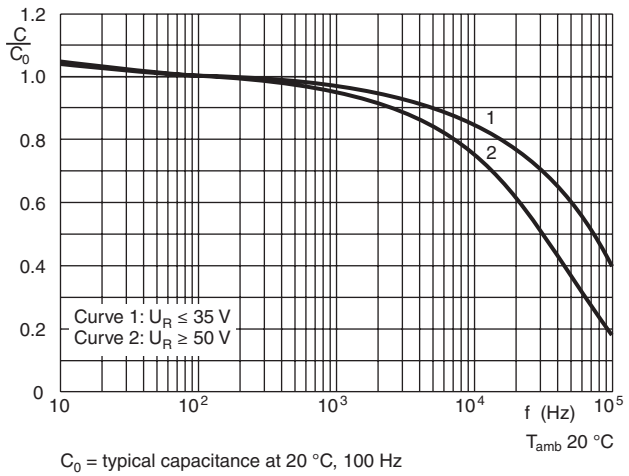
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R + 3$ µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D ≤ 10 mm	typ. 16 nH
	Case Ø D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)



C_0 = typical capacitance at 20 °C, 100 Hz

Fig.5 Typical multiplier of capacitance as a function of ambient temperature



C_0 = typical capacitance at 20 °C, 100 Hz

Fig.6 Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

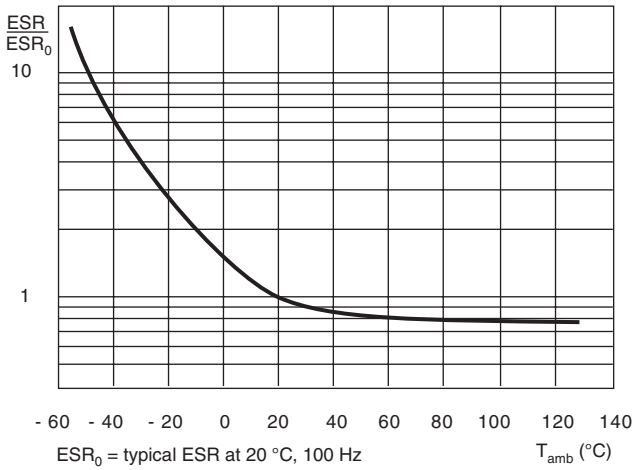


Fig.7 Typical multiplier of ESR as a function of ambient temperature

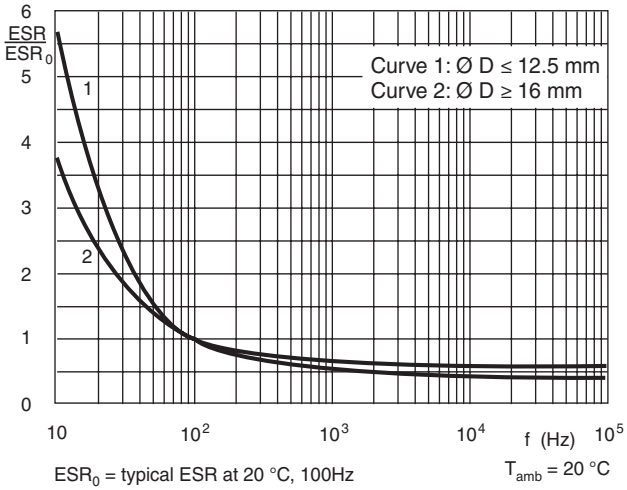


Fig.8 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

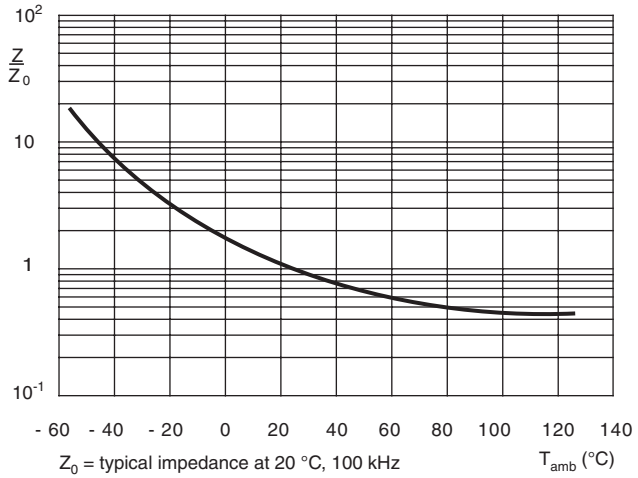


Fig.9 Typical multiplier of impedance as a function of ambient temperature

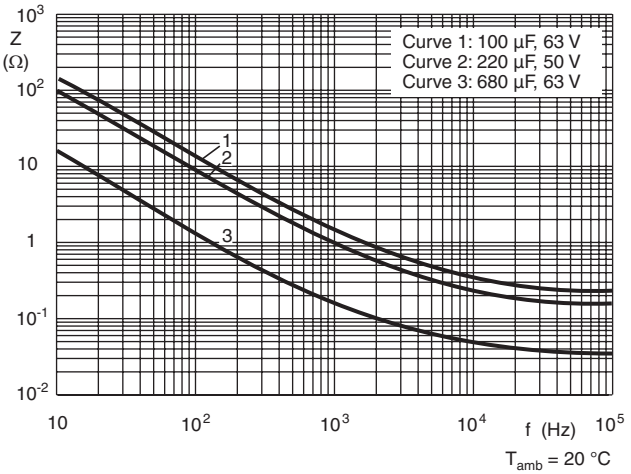


Fig.11 Typical impedance as a function of frequency

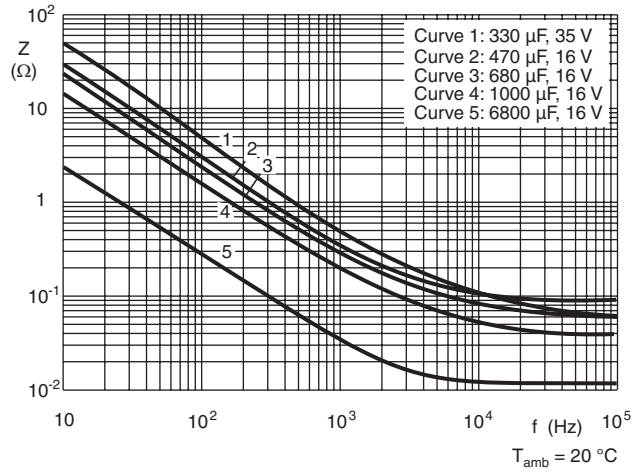
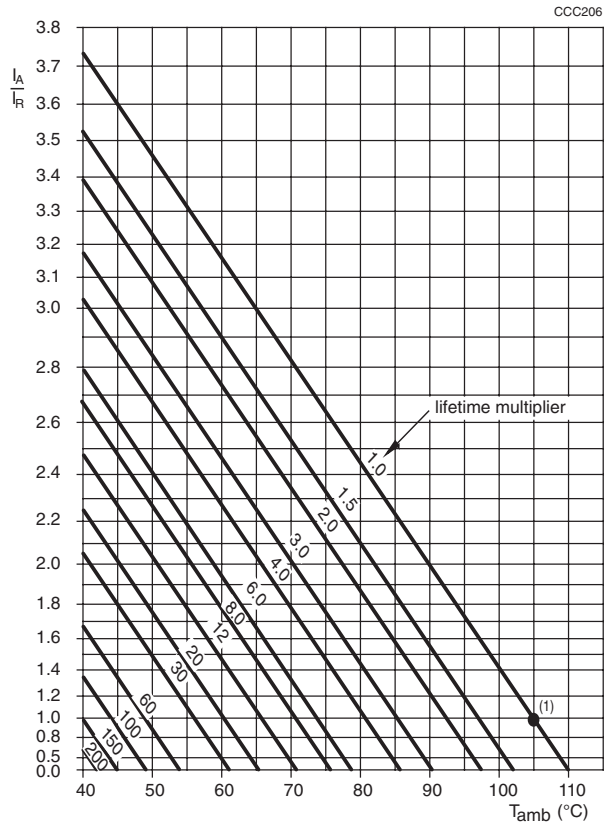


Fig.10 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

Table 3

ENDURANCE TEST DURATION AND USEFUL LIFE AS A FUNCTION OF CASE SIZE			
NOMINAL CASE SIZE Ø D x L (mm)	**CASE CODE**	**ENDURANCE at 105 °C (h)**	**USEFUL LIFE at 105 °C (h)**
8 x 12	13	3000	4000
8 x 15	13L	3000	4000
10 x 12	14	3000	4000
10 x 16	15	3000	6000
10 x 20	16	3000	6000
12.5 x 20	17	3000	7000
12.5 x 25	18	5000	8000
12.5 x 35	18LL	5000	8000
16 x 20	19a	3000	7000
16 x 25	19	5000	10 000
16 x 31	20	5000	10 000
16 x 35	21	5000	10 000
18 x 20	1820	3000	7000
18 x 31	1831	6000	10 000



I_A = actual ripple current at 100 kHz
I_R = rated ripple current at 100 kHz, 105 °C
(1) Useful life at 105 °C and I_R applied; see Table 4

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	I_R MULTIPLIER	
	Ø = 8 to 12.5 mm	Ø = 16 mm and 18 mm
100	0.65	0.76
300	0.76	0.85
1000	0.85	0.91
3000	0.89	0.94
10 000	0.90	0.96
30 000	0.97	0.98
100 000	1.00	1.00

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; for test duration see Table 3	Δ C/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; for test duration see Table 3	Δ C/C: ± 30 % tan δ ≤ 3 x spec. limit I_{L2} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 h after test: U_R to be applied for 30 min., 24 to 48 h before measurement	Δ C/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit

Aluminum Capacitors
Radial, High Temperature Miniature

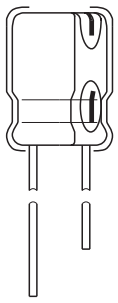
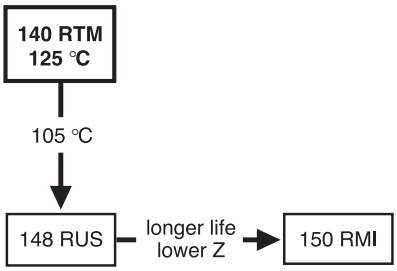


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Very long useful life:
  2500 to 4000 h at 125 °C, high stability, high reliability
- Extended temperature range up to 125 °C
- High ripple current capability
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- EDP, telecommunication, industrial, automotive and military
- Smoothing, filtering, buffering in SMPS
- High ambient temperature environments

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance value (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (125 °C)
- Negative terminal identification
- Series number (140)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	10 x 12 to 18 x 31
Rated capacitance range, C_R	22 to 4700 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	- 55 to + 125 °C
Endurance test at 125 °C	2000 h
Useful life at 125 °C	2500 to 4000 h
Useful life at 40 °C, 1.6 x I_R applied	300 000 h
Shelf life at 0 V, 125 °C	500 h
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/125/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)						
	6.3	**10**	**16**	**25**	**35**	**50**	**63**
22	-	-	-	-	-	-	10 x 12
47	-	-	-	-	-	10 x 12	10 x 12
100	-	-	-	-	10 x 12	10 x 16	10 x 20
220	-	-	10 x 12	10 x 16	10 x 16	12.5 x 20	16 x 20
330	-	10 x 12	10 x 16	10 x 20	-	12.5 x 20	16 x 20
470	-	10 x 16	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25
	-	-	-	-	-	16 x 20	-
1000	-	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	18 x 31
	-	-	-	16 x 20	-	-	-
1200	10 x 16	-	-	-	-	-	-
2200	10 x 20	12.5 x 25	16 x 25	16 x 31	18 x 31	-	-
	-	16 x 20	-	-	-	-	-
3300	-	16 x 25	16 x 31	18 x 31	-	-	-
4700	-	16 x 31	18 x 31	-	-	-	-

DIMENSIONS in millimeters, **AND AVAILABLE FORMS**

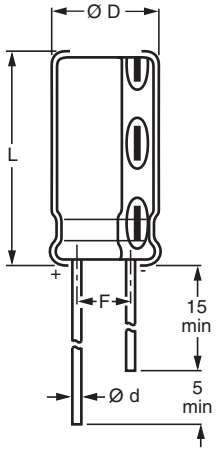


Fig.2 **Form CA**: Long leads

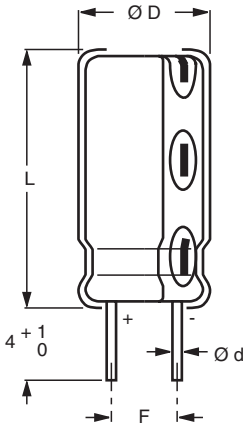


Fig.3 **Form CB**: Cut leads

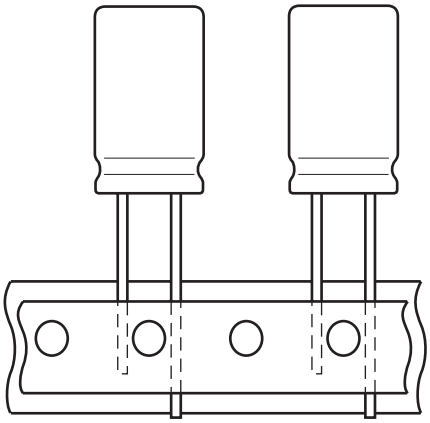


Fig. 4 **Form TFA**: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**		
							FORM CA	**FORM CB**	**FORM TFA**
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
18 x 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	-

Note

Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 kHz, 125 °C
I_{L1}	max. leakage current after 1 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 140 series

220 µF/25 V; ± 20 %

Nominal case size: Ø 10 x 16 mm; Form TFA

Ordering Code: MAL214036221E3
Former 12NC: 2222 140 36221

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 125 °C (mA)	I_{L1} 1 min (µA)	tan δ 100 Hz	Z 100 kHz + 20 °C (Ω)	Z 100 kHz - 40 °C (Ω)	ORDERING CODE MAL2140		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
6.3	1200	10 x 16	760	79	0.28	0.15	1.10	53122E3	63122E3	33122E3
	2200	10 x 20	850	142	0.28	0.12	0.85	53222E3	63222E3	33222E3
10	330	10 x 12	480	36	0.20	0.200	1.40	54331E3	64331E3	34331E3
	470	10 x 16	760	50	0.20	0.150	1.10	54471E3	64471E3	34471E3
	1000	10 x 20	850	103	0.20	0.120	0.85	54102E3	64102E3	34102E3
	2200	12.5 x 25	1400	223	0.24	0.050	0.40	94225E3	94226E3	94223E3
	2200	16 x 20	1400	223	0.24	0.050	0.40	54222E3	64222E3	34222E3
	3300	16 x 25	1900	333	0.24	0.034	0.25	54332E3	64332E3	34332E3
	4700	16 x 31	2200	473	0.24	0.030	0.20	54472E3	64472E3	34472E3
16	220	10 x 12	480	38	0.16	0.200	1.40	55221E3	65221E3	35221E3
	330	10 x 16	760	56	0.16	0.150	1.10	55331E3	65331E3	35331E3
	470	10 x 16	760	78	0.16	0.150	1.10	55471E3	65471E3	35471E3
	1000	12.5 x 20	1200	163	0.16	0.073	0.50	55102E3	65102E3	35102E3
	2200	16 x 25	1900	355	0.18	0.034	0.25	55222E3	65222E3	35222E3
	3300	16 x 31	2200	531	0.18	0.030	0.20	55332E3	65332E3	35332E3
	4700	18 x 31	2200	755	0.18	0.030	0.20	55472E3	65472E3	-
25	220	10 x 16	750	58	0.14	0.150	1.10	56221E3	66221E3	36221E3
	330	10 x 20	850	86	0.14	0.120	0.85	56331E3	66331E3	36331E3
	470	10 x 20	850	121	0.14	0.120	0.85	56471E3	66471E3	36471E3
	1000	12.5 x 25	1400	253	0.14	0.050	0.40	96105E3	96106E3	96103E3
	1000	16 x 20	1400	253	0.14	0.050	0.40	56102E3	66102E3	36102E3
	2200	16 x 31	2200	553	0.16	0.030	0.20	56222E3	66222E3	36222E3
	3300	18 x 31	2200	828	0.16	0.030	0.20	56332E3	66332E3	-

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 125 °C (mA)	I_{L1} 1 min (µA)	tan δ 100 Hz	Z 100 kHz + 20 °C (Ω)	Z 100 kHz - 40 °C (Ω)	ORDERING CODE MAL2140		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
35	100	10 **x** 12	480	38	0.12	0.200	1.40	50101E3	60101E3	30101E3
	220	10 x 16	760	80	0.12	0.150	1.10	50221E3	60221E3	30221E3
	470	12.5 x 20	1200	168	0.12	0.073	0.50	50471E3	60471E3	30471E3
	1000	16 x 25	1500	353	0.12	0.034	0.25	50102E3	60102E3	30102E3
	2200	18 x 31	2200	773	0.14	0.030	0.20	50222E3	60222E3	-
50	47	10 x 12	300	27	0.10	0.300	2.00	51479E3	61479E3	31479E3
	100	10 x 16	380	53	0.10	0.200	1.40	51101E3	61101E3	31101E3
	220	12.5 x 20	580	113	0.10	0.120	0.85	51221E3	61221E3	31221E3
	330	12.5 x 20	870	168	0.10	0.120	0.85	51331E3	61331E3	31331E3
	470	12.5 x 25	1100	238	0.10	0.085	0.60	91475E3	91476E3	91473E3
	470	16 x 20	1100	238	0.10	0.085	0.60	51471E3	61471E3	31471E3
	1000	16 x 31	1700	503	0.10	0.045	0.30	51102E3	61102E3	31102E3
63	22	10 x 12	380	17	0.10	0.300	2.00	58229E3	68229E3	38229E3
	47	10 x 12	380	33	0.10	0.300	2.00	58479E3	68479E3	38479E3
	100	10 x 20	650	66	0.10	0.160	1.10	58101E3	68101E3	38101E3
	220	16 x 20	1100	142	0.10	0.085	0.60	58221E3	68221E3	38221E3
	330	16 x 20	1100	211	0.10	0.085	0.60	58331E3	68331E3	38331E3
	470	16 x 25	1500	299	0.10	0.055	0.40	58471E3	68471E3	38471E3
	1000	18 x 31	1800	633	0.10	0.040	0.28	58102E3	68102E3	-

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.01\ C_R \times U_R + 3$ µA
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 10 mm	typ. 16 nH
	Case Ø D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)

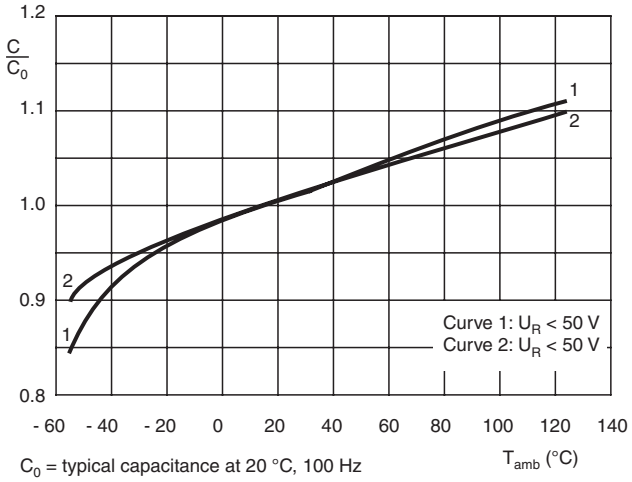


Fig.5 Typical multiplier of capacitance as a function of ambient temperature

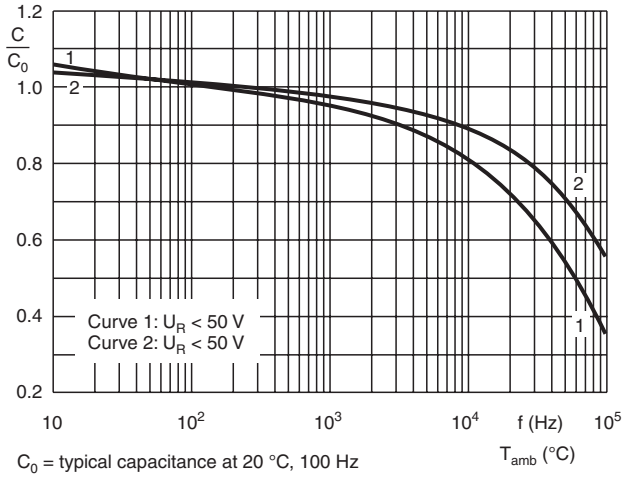


Fig.6 Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

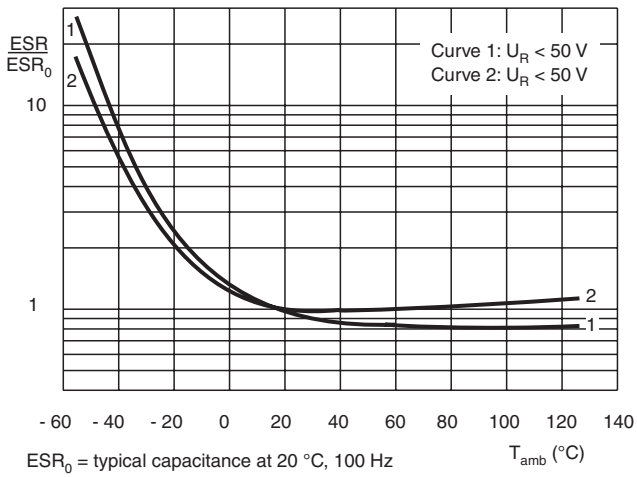


Fig.7 Typical multiplier of ESR as a function of ambient temperature

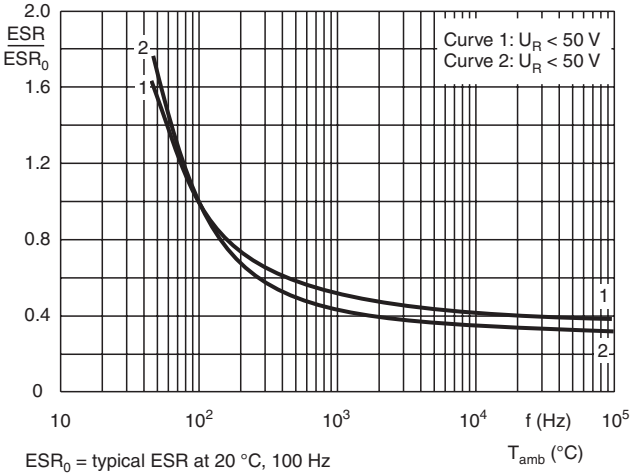
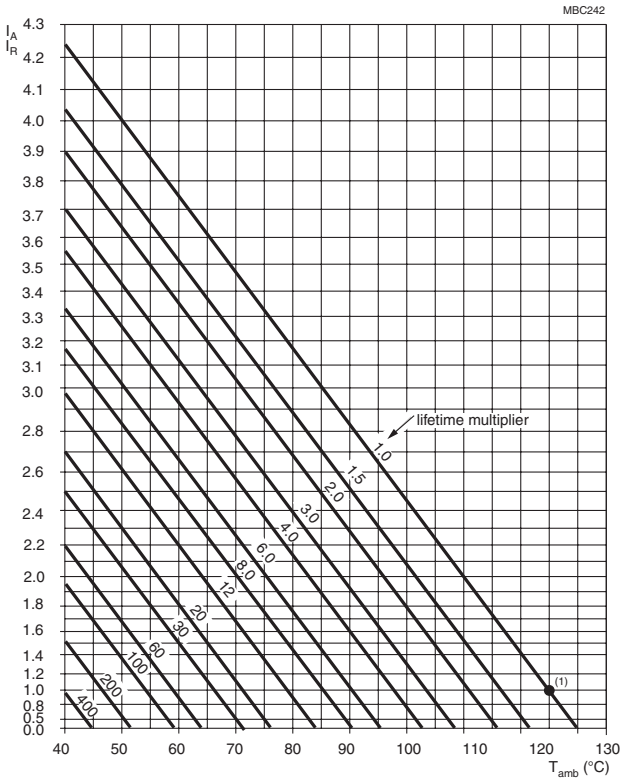


Fig.8 Typical multiplier of ESR as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

Table 2

ENDURANCE AND USEFUL LIFE AS A FUNCTION OF CASE SIZE			
NOMINAL CASE SIZE Ø D x L (mm)	**CASE CODE**	**ENDURANCE TEST AT 125 °C (h)**	**USEFUL LIFE AT 125 °C (h)**
10 x 12	14	2000	2500
10 x 16	15	2000	3000
10 x 20	16	2000	3000
12.5 x 20	17	2000	3000
12.5 x 25	18	2000	3000
16 x 20	19a	2000	3000
16 x 25	19	2000	4000
16 x 31	20	2000	4000
18 x 31	1831	2000	4000



I_A = actual ripple current at 100 kHz
I_R = rated ripple current at 100 kHz, 125 °C
(1) Useful life at 125 °C and I_R applied: see Table 3

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTILPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 V	U_R = 50 and 63 V
50	0.60	0.50	0.35
100	0.70	0.65	0.50
300	0.85	0.80	0.65
1000	0.90	0.85	0.80
3000	0.95	0.90	0.90
10 000	1.00	0.95	0.90
100 000	1.00	1.00	1.00

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R applied; 2000 hours	ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; for test duration see Table 3	ΔC/C: ± 30 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ 2 x spec. limit

Aluminum Capacitors Solid Al, Radial Pearl Miniature

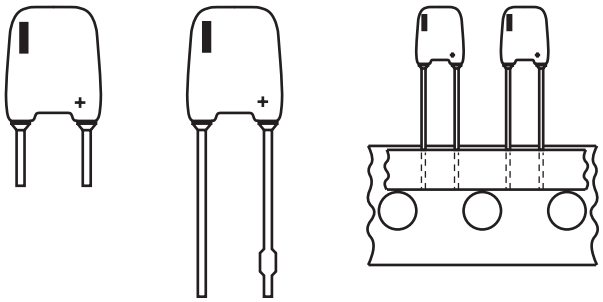
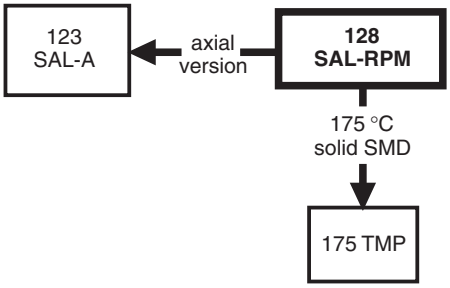


Fig.1 Component outlines



QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Maximum case sizes (H x W x T in mm)	10 x 7 x 3.5 to 10 x 8 x 6
Rated capacitance range (E6 series), C_R	0.22 µF to 68 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 V to 40 V
Category temperature range:	
U_R = 6.3 to 40 V	- 55 °C to + 85 °C
U_C = 6.3 to 25 V	- 55 °C to + 125 °C
Endurance test at 125 °C	10 000 hours
Useful life at 125 °C	20 000 hours
Useful life at 175 °C	2000 hours
Useful life at 40 °C, I_R applied	> 300 000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 60384-4/EN 130300
Climatic category IEC 60068	55/125/56

FEATURES

- Polarized aluminum electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, max. height 10 mm, resin dipped, orange colored
- Extremely long useful life, 20 000 hours/125 °C
- Extended high temperature range up to 175 °C
- Excellent low temperature, impedance and ESR behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.3 x U_R allowed
- AC voltage up to 0.8 x U_R allowed

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Audio-video, automotive, industrial high temperature and telecommunication
- Smoothing, filtering and buffering
- For small power supplies, DC/DC converters

MARKING

The capacitors are marked (where possible) with the following information:

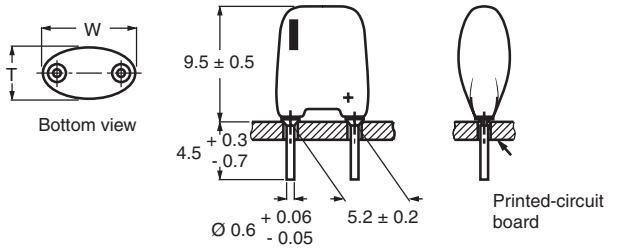
- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V) and category voltage if applicable
- Date code in accordance with IEC60062
- Name of manufacturer
- '**l**' sign to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number

MOUNTING

When bending, cutting or straightening the leads, ensure that the capacitor body is relieved of stress.
Bending after soldering must be avoided.

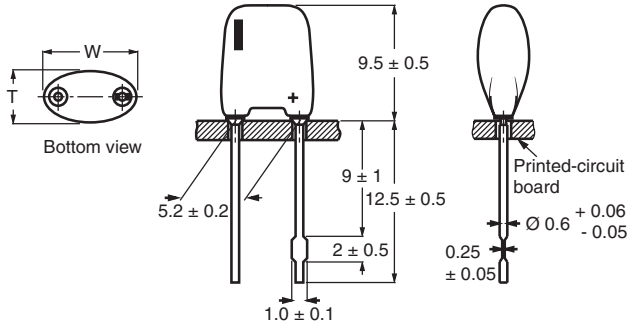
SELECTION CHART FOR C_R, U_R, U_C AND RELEVANT MAXIMUM CASE SIZES (H x W x T in mm)					
C_R (µF)	**U_R (V) at T_{amb} = 85 °C**				
	6.3	**10**	**16**	**25**	**40**
	U_C (V) at T_{amb} = 125 °C				
	6.3	**10**	**16**	**25**	**25**
0.22	-	-	-	-	10 x 7 x 3.5
0.33	-	-	-	-	10 x 7 x 4
0.47	-	-	-	-	10 x 7 x 5
0.68	-	-	-	10 x 7 x 3.5	10 x 7 x 5
1	-	-	-	10 x 7 x 3.5	10 x 7 x 5
1.5	-	-	-	10 x 7 x 3.5	10 x 8 x 6
2.2	-	-	10 x 7 x 3.5	10 x 7 x 4	10 x 8 x 6
3.3	-	-	10 x 7 x 3.5	10 x 7 x 5	-
4.7	-	10 x 7 x 3.5	10 x 7 x 4	10 x 8 x 5	-
6.8	-	10 x 7 x 3.5	10 x 7 x 4	10 x 8 x 5	-
10	10 x 7 x 3.5	10 x 7 x 4	10 x 7 x 5	10 x 8 x 6	-
15	-	10 x 7 x 4	10 x 8 x 5	-	-
22	10 x 7 x 4	10 x 7 x 5	10 x 8 x 6	-	-
33	10 x 7 x 5	10 x 8 x 5	-	-	-
47	10 x 8 x 5	10 x 8 x 6	-	-	-
68	10 x 8 x 6	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



The diameter of the mounting holes in the printed-circuit board is 0.8 ± 0.1 mm.
Flanges are provided with degassing grooves.

Fig.2 **Form CB:** Short leads, in boxes



The diameter of the mounting holes in the printed-circuit board is 0.8 ± 0.1 mm, except for the hole of the anode lead of Form CA capacitors: 1.3 - 0.2 mm.
Flanges are provided with degassing grooves.

Fig.3 **Form CA:** Long leads with keyed polarity, in boxes

Table 1

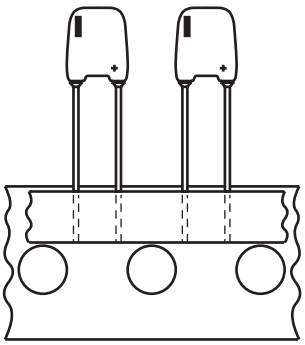
DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**						
MAXIMUM CASE SIZE H x W x T (mm)	**CASE CODE**	**MASS (g)**	**PACKAGING QUANTITIES**			
			FORM CA [1]	**FORM CB [1]**	**FORM TR+**	**FORM TFA**
10 x 7 x 3.5	20	≈ 0.25	1000	1000	2000	1000
10 x 7 x 4	30	≈ 0.30	1000	1000	2000	1000
10 x 7 x 5	40	≈ 0.35	1000	1000	1000	1000
10 x 8 x 5	50	≈ 0.50	1000	1000	1000	1000
10 x 8 x 6	60	≈ 0.60	1000	1000	1000	1000

Notes

[1] In plastic bags of 200 units each.

Detailed tape dimensions see section 'PACKAGING'.

TAPED PRODUCTS



Form TR +: Taped on reel, positive leading
Form TFA : Taped in ammopack

Fig.4 Taped versions

ELECTRICAL DATA	
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	max. RMS ripple current no necessary DC applied
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	max./typ. equivalent series resistance at 100 Hz
Z	max. impedance at 100 kHz

Note
Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C to 25 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %.

ORDERING EXAMPLE

Maximum case size: 10 x 7 x 5 mm; Form CB
Electrolytic capacitors 128 series 10 µF/16 V; ± 20 %

Ordering code: MAL212855109E3
Former 12NC: 2281128 55109

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	MAX. ESR 100 Hz (Ω)	TYP. ESR 100 Hz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2128.....			
											FORM CB	FORM CA	FORM TR + REEL	FORM TFA AMMO
6.3	6.3	10	10 x 7 x 3.5	22.4	320	595	2	20	8	2.0	53109E3	73109E3	23109E3	33109E3
		22	10 x 7 x 4	32.9	470	870	4	9	3.5	1.0	53229E3	73229E3	23229E3	33229E3
		33	10 x 7 x 5	65.4	595	1100	5	6.1	2	0.70	53339E3	73339E3	23339E3	33339E3
		47	10 x 8 x 5	118.4	740	1360	7	4.3	2	0.50	53479E3	73479E3	23479E3	33479E3
		68	10 x 8 x 6	153.0	800	1650	11	3.0	1.5	0.40	53689E3	73689E3	23689E3	33689E3
10	10	4.7	10 x 7 x 3.5	16.1	230	425	2	43	16	3.00	54478E3	74478E3	24478E3	34478E3
		6.8	10 x 7 x 3.5	18.9	270	500	2	30	12	2.20	54688E3	74688E3	24688E3	34688E3
		10	10 x 7 x 4	21.7	310	573	3	20	9	1.70	54109E3	74109E3	24109E3	34109E3
		15	10 x 7 x 4	27.3	390	720	4	14	7	1.20	54159E3	74159E3	24159E3	34159E3
		22	10 x 7 x 5	51.7	470	870	6	9	3.5	0.90	54229E3	74229E3	24229E3	34229E3
		33	10 x 8 x 5	81.6	510	940	8	6.1	2	0.60	54339E3	74339E3	24339E3	34339E3
		47	10 x 8 x 6	105.4	620	1140	12	4.3	1.5	0.40	54479E3	74479E3	24479E3	34479E3
16	16	2.2	10 x 7 x 3.5	14.0	200	370	2	91	25	4.50	55228E3	75228E3	25228E3	35228E3
		3.3	10 x 7 x 3.5	16.1	230	425	2	61	26	3.30	55338E3	75338E3	25338E3	35338E3
		4.7	10 x 7 x 4	18.9	270	500	2	43	14	2.30	55478E3	75478E3	25478E3	35478E3
		6.8	10 x 7 x 4	22.4	320	590	3	30	11	1.65	55688E3	75688E3	25688E3	35688E3
		10	10 x 7 x 5	42.9	390	720	4	20	6	1.10	55109E3	75109E3	25109E3	35109E3
		15	10 x 8 x 5	71.2	445	820	6	14	5	0.85	55159E3	75159E3	25159E3	35159E3
		22	10 x 8 x 6	86.7	510	940	9	9	3.5	0.65	55229E3	75229E3	25229E3	35229E3
25	25	0.68	10 x 7 x 3.5	7.7	110	200	2	295	85	17.00	56687E3	76687E3	26687E3	36687E3
		1	10 x 7 x 3.5	9.1	130	240	2	200	71	12.50	56108E3	76108E3	26108E3	36108E3
		1.5	10 x 7 x 3.5	10.8	155	285	2	135	48	10.00	56158E3	76158E3	26158E3	36158E3
		2.2	10 x 7 x 4	13.6	195	360	2	91	34	7.00	56228E3	76228E3	26228E3	36228E3
		3.3	10 x 7 x 5	16.1	230	425	2	61	19	5.20	56338E3	76338E3	26338E3	36338E3
		4.7	10 x 8 x 5	25.3	270	500	3	43	14	3.50	56478E3	76478E3	26478E3	36478E3
		6.8	10 x 8 x 6	52.7	310	570	4	30	11	2.70	56688E3	76688E3	26688E3	36688E3
		10	10 x 8 x 6	64.8	360	660	6	20	9	2.00	56109E3	76109E3	26109E3	36109E3
25	40	0.22	10 x 7 x 3.5	4.2	60	115	2	910	275	27.00	57227E3	77227E3	27227E3	37227E3
		0.33	10 x 7 x 4	5.3	75	140	2	610	172	20.00	57337E3	77337E3	27337E3	37337E3
		0.47	10 x 7 x 5	10.4	95	175	2	430	114	15.00	57477E3	77477E3	27477E3	37477E3
		0.68	10 x 7 x 5	12.1	110	205	2	295	89	10.00	57687E3	77687E3	27687E3	37687E3
		1	10 x 8 x 5	20.0	125	230	2	200	45	7.00	57108E3	77108E3	27108E3	37108E3
		1.5	10 x 8 x 6	25.5	150	280	2	135	35	5.50	57158E3	77158E3	27158E3	37158E3
		2.2	10 x 8 x 6	33.1	195	360	2	91	28	4.20	57228E3	77228E3	27228E3	37228E3

Note
tan δ at 100 Hz for all types < 0.10

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} < 0.3 \times U_R$
Maximum peak AC voltage	Reverse voltage applied	≤ 2 V
Maximum peak AC voltage, without reverse voltage applied	$T_{amb} \leq 85$ °C:	
	at f ≤ 0.1 Hz	$0.30 \times U_R$
	at 0.1 Hz < f ≤ 1 Hz	$0.45 \times U_R$
	at 1 Hz < f ≤ 10 Hz	$0.60 \times U_R$
	at 10 Hz < f ≤ 50 Hz	$0.65 \times U_R$
	at f > 50 Hz	$0.80 \times U_R$
	85 °C < T_{amb} ≤ 125 °C:	
	at f ≤ 0.1 Hz	$0.15 \times U_R$
	at 0.1 Hz < f ≤ 1 Hz	$0.22 \times U_R$
	at 1 Hz < f ≤ 10 Hz	$0.30 \times U_R$
	at 10 Hz < f ≤ 50 Hz	$0.32 \times U_R$
	at f > 50 Hz	$0.40 \times U_R$
Inductance		
Equivalent series inductance (ESL)	Case sizes 10 x 7 x 3.5 mm to 10 x 7 x 5 mm	typ. 9 nH to 14 nH
	Case sizes 10 x 8 x 5 mm and 10 x 8 x 6 mm	typ. 11 nH to 16 nH
	All case sizes	max. 20 nH
Dissipation		
Maximum power dissipation	Case sizes 10 x 7 x 3.5 mm to 10 x 7 x 5 mm	P_{125} = 88 mW
	Case sizes 10 x 8 x 5 mm and 10 x 8 x 6 mm	P_{125} = 104 mW
Current		
Maximum leakage current	After 5 minutes at U_R and T_{amb} = 25 °C	$I_{L5} \leq 0.025\ C_R \times U_R$ or 2 µA whichever is greater; see Table 2
Typical leakage current	15 s at U_R and T_{amb} = 25 °C:	
	U_R = 6.3 to 16 V	≈ 0.2 x value stated in Table 2
	U_R = 25 to 40 V	≈ 0.1 x value stated in Table 2

VOLTAGE

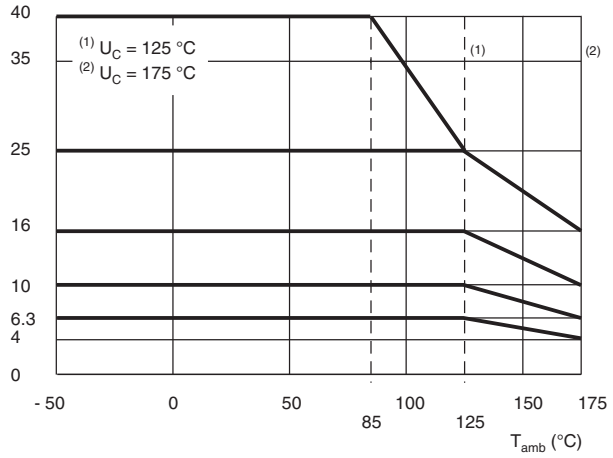


Fig.5 Maximum permissible voltage up to T_{amb} = 175 °C

RIPPLE CURRENT (I_R)						
PARAMETER	**T_{amb}**					
	25 °C	**40 °C**	**65 °C**	**85 °C**	**105 °C**	**125 °C**
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

Notes

(1) Applying the maximum RMS ripple current given in Table 2 will cause a device temperature of 138 °C

(2) The 100 kHz values in Table 2 for other temperatures are to be calculated with the above I_R multipliers:

CAPACITANCE (C)

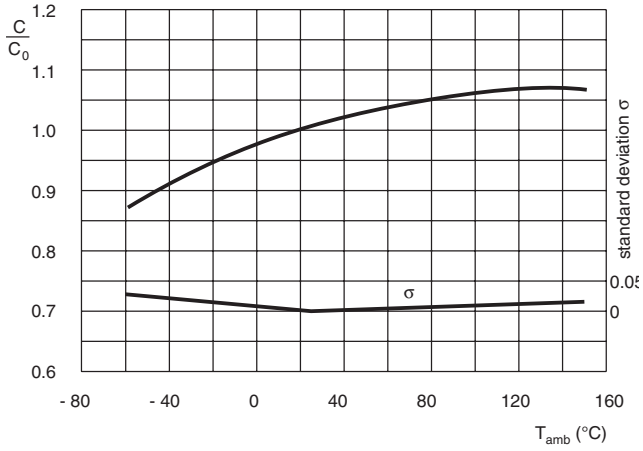


Fig.6 Typical multiplier of capacitance and standard deviation as functions of ambient temperature

TYPICAL CAPACITANCE CHANGE AFTER ENDURANCE TEST AT T_{AMB} = 125 °C

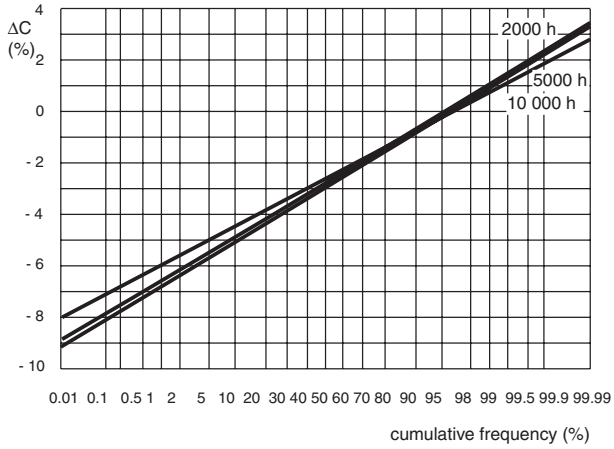
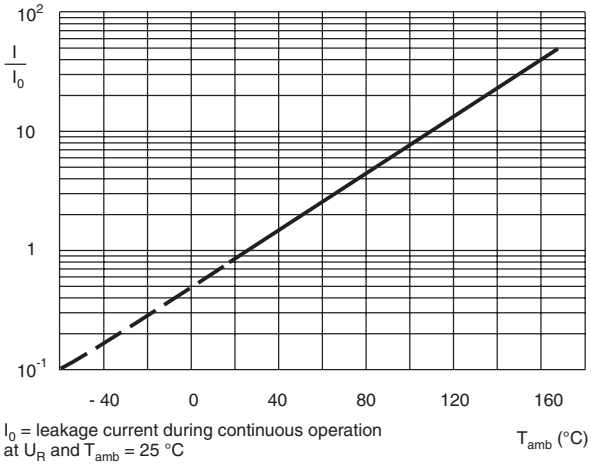


Fig.7 Change of capacitance as a function of cumulative frequency after endurance test

LEAKAGE CURRENT



I_0 = leakage current during continuous operation at U_R and T_{amb} = 25 °C

Fig.8 Typical multiplier of leakage current as a function of ambient temperature

TYPICAL LEAKAGE CURRENT CHANGE AFTER ENDURANCE TEST AT T_{AMB} = 125 °C

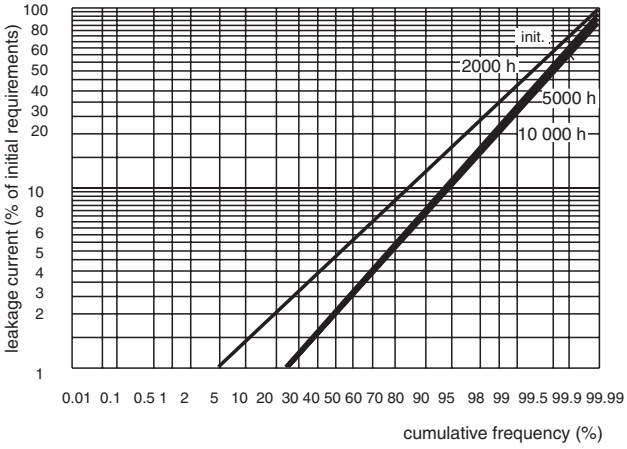


Fig.9 Change of capacitance as a function of cumulative frequency after endurance test

DISSIPATION FACTOR (tan δ)

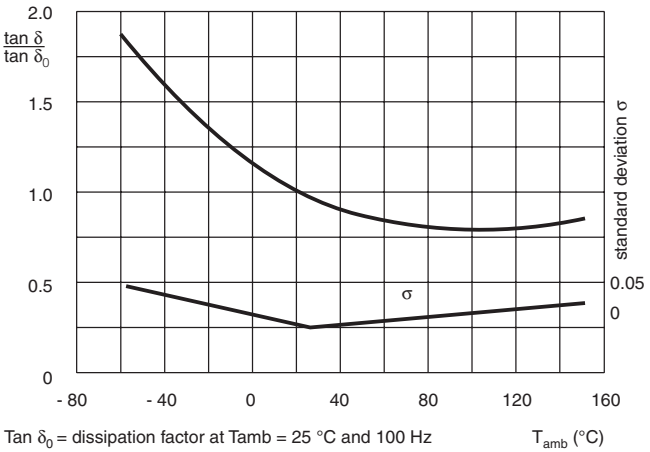


Fig.10 Typical multiplier of dissipation factor and standard deviation as functions of ambient temperature

TYPICAL tan δ CHANGE AFTER ENDURANCE TEST AT T_{amb} = 125 °C

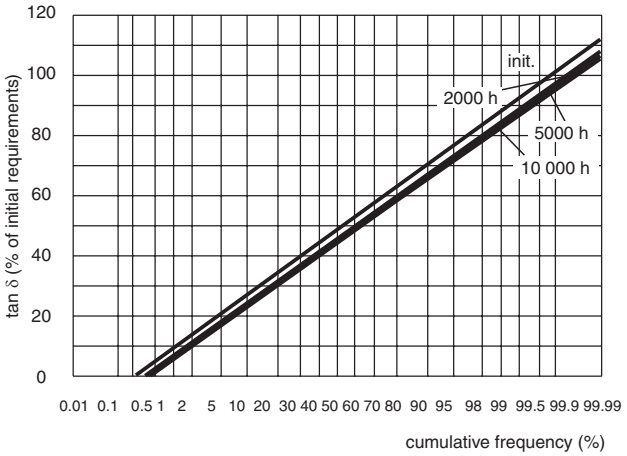


Fig.11 tan δ change of capacitance as a function of cumulative frequency after endurance test

EQUIVALENT SERIES RESISTANCE (ESR)

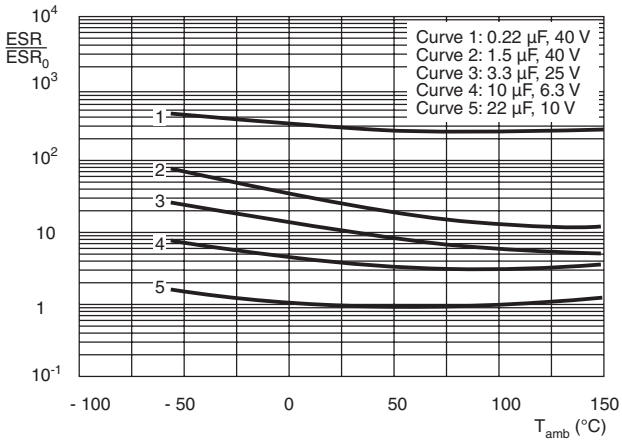


Fig.12 Typical multiplier of ESR at 100 Hz as a function of ambient temperature

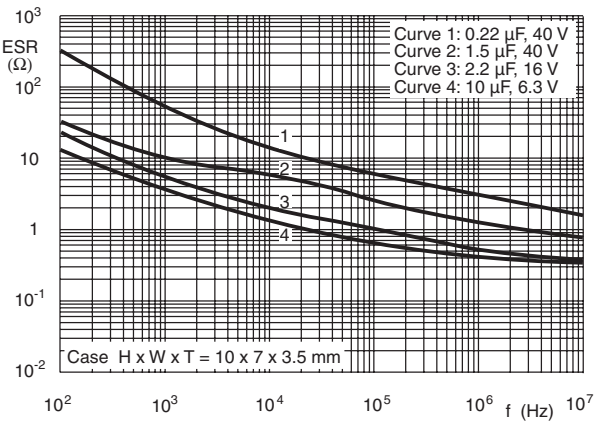


Fig.13 Typical ESR at 25 °C as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

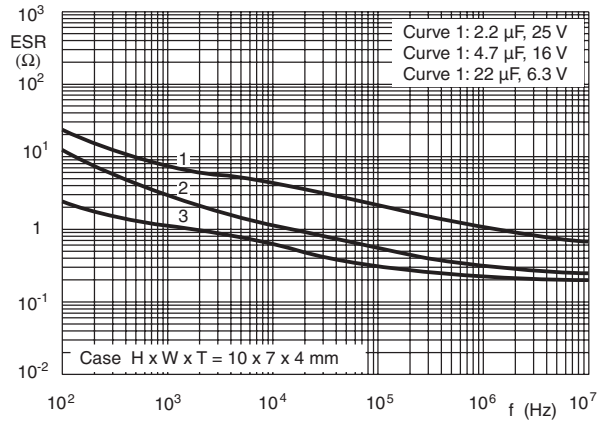


Fig.14 Typical ESR at 25 °C as a function of frequency

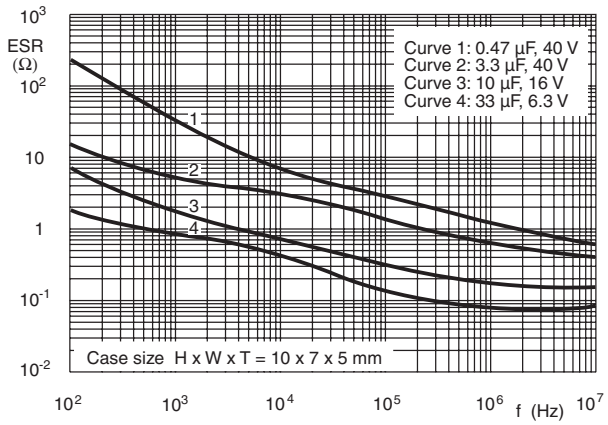


Fig.15 Typical ESR at 25 °C as a function of frequency

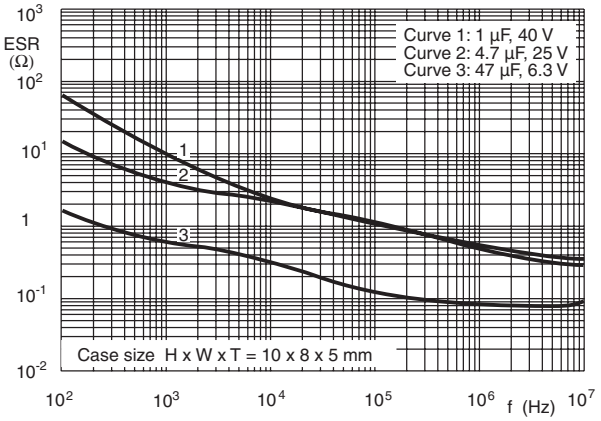


Fig.16 Typical ESR as a function of frequency

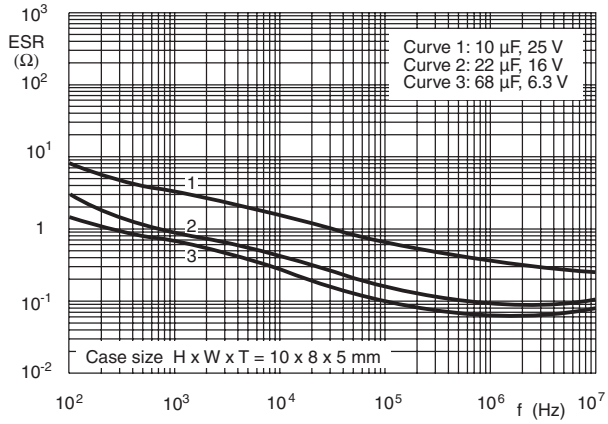


Fig.17 Typical ESR at 25 °C as a function of frequency

IMPEDANCE (Z)

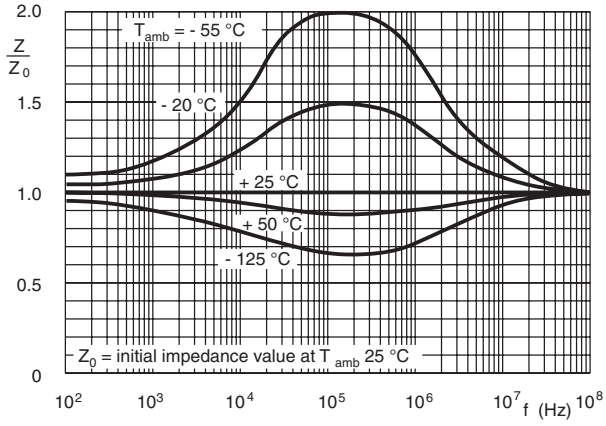


Fig.18 Typical multiplier of impedance as a function of frequency at different ambient temperatures

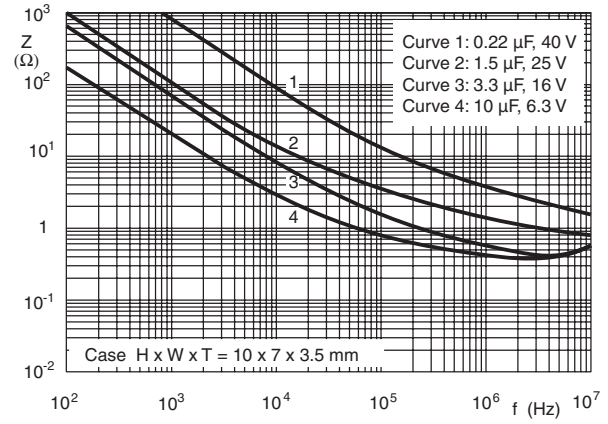


Fig.19 Typical impedance at 25 °C as a function of frequency

IMPEDANCE (Z)

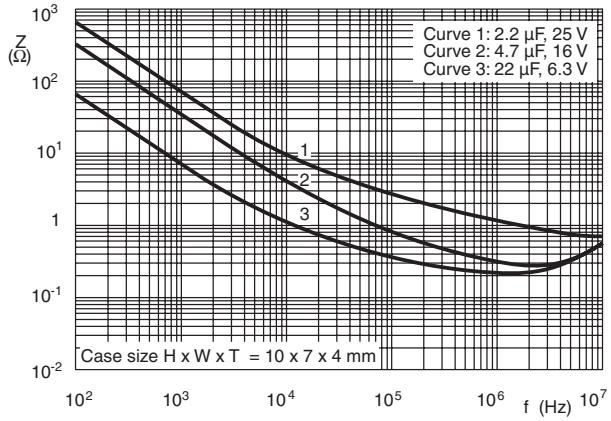


Fig.20 Typical impedance at 25 °C as a function of frequency

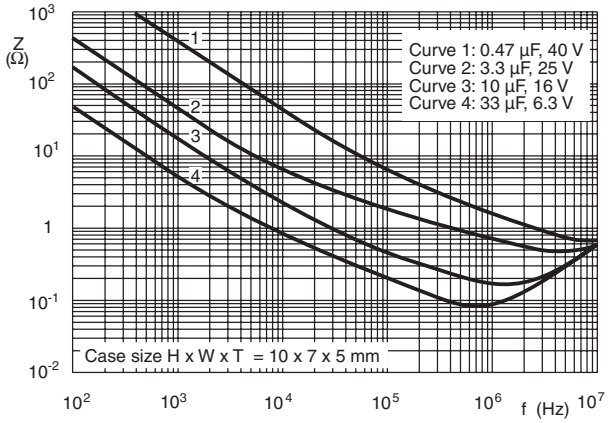


Fig.21 Typical impedance at 25 °C as a function of frequency

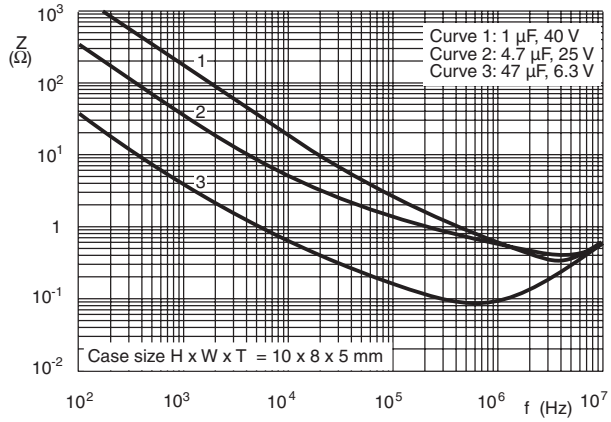


Fig.22 Typical impedance at 25 °C as a function of frequency

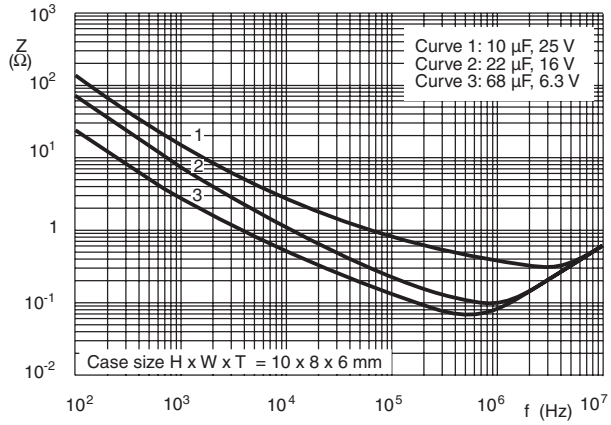


Fig.23 Typical impedance at 25 °C as a function of frequency

Table 3

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R = 6.3 V to 25 V with U_R applied; U_R = 40 V with U_C applied; 10 000 hours	$\Delta C/C$: ± 10 % tan $\delta \leq$ 1.2 x spec. limit $Z \leq$ 1.2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30302 subclause 1.8.1	T_{amb} = 125 °C; I_R applied and: U_R = 6.3 V to 25 V with U_R applied; U_R = 40 V with U_C applied; 20 000 hours	$\Delta C/C$: ± 15 % tan $\delta \leq$ 1.5 x spec. limit $Z \leq$ 1.5 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit, no visible damage total failure percentage: < 1%
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; 500 hours	$\Delta C/C$: ± 10 % tan $\delta \leq$ 1.2 x spec. limit $I_{L5} \leq$ spec. limit
Charge and discharge	IEC 60384-4-2 subclause 9.21	10^6 cycles without series resistance: 0.5 s to U_R; 0.5 s to ground	$\Delta C/C$: ± 5 % no short or open circuit, no visible damage
Solvent resistance	IEC 60068-2-45, test XA IEC 60653	immersion: 5 min ± 0.5 min with or without ultrasonic at 55 °C ± 5 °C solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
Extended vibration	IEC 60068-2-6 test Fc	10 Hz to 2000 Hz; 1.5 mm or 20 g; 1 octave/min; 3 directions; 1 sweep per direction; no voltage applied	no intermittent contacts no breakdown no open circuiting no mechanical damage $\Delta C/C$: ± 5 % tan $\delta \leq$ 1.2 x spec. limit $Z \leq$ 1.2 x spec. limit $I_{L5} \leq$ 1.5 x spec. limit
Shock	IEC 60068-2-27 test Ea	half-sine or sawtooth pulse shape; 50 g; 11 ms; 3 successive shocks in each direction of 3 mutually perpendicular axes; no voltage applied	no intermittent contacts no breakdown no open circuiting no mechanical damage $\Delta C/C$: ± 5 % tan $\delta \leq$ 1.2 x spec. limit $Z \leq$ 1.2 x spec. limit $I_{L5} \leq$ 1.5 x spec. limit
Passive flammability	IEC 60695-2-2	capacitor mounted to a vertical printed-circuit board, one flame on capacitor body; T_{amb} = 20 °C to 25 °C; test duration = 20 s	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s; no burning particles must drop from the sample

Double Layer Capacitors

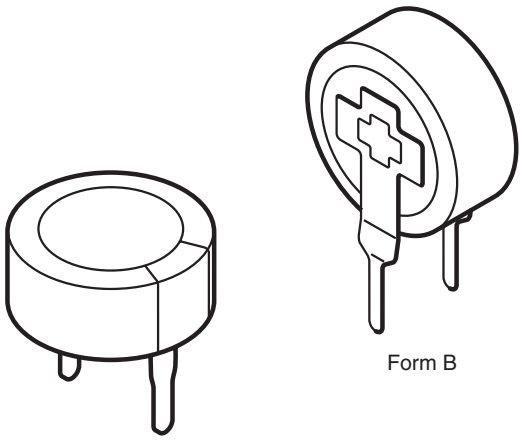


Fig.1 Component outline

FEATURES

- Polarized capacitor with high charge density, alternative product to rechargeable backup batteries
- Dielectric: electric double layer
- Radial leads, cylindrical case, insulated with a blue vinyl sleeve
- Available in both vertical and low-profile versions
- Unlimited charge and discharge cycle numbers
- No charge-discharge control circuitry and no series resistor necessary
- Maintenance-free, no periodic replacement or service necessary
- Ecologically beneficial (no Cd, no Li)
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Energy storage, for backup of semiconductor memories (CMOS) in all fields of electronics
- Telecommunication, audio-video, EDP
- General industrial, clock and timer systems

MARKING

The capacitors are marked with the following information:

- Rated capacitance (in F)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Name of manufacturer
- Negative terminal identification
- Upper category temperature (at 85 °C types only)

QUICK REFERENCE DATA

DESCRIPTION	VALUE			
	STANDARD FORM A	HIGH VOLTAGE FORM A	HIGH TEMPERATURE FORM A	VERTICAL, MINIATURIZED FORM B
Nominal case sizes (Ø D x L in mm)	13 x 7 and 21 x 7.5	13 x 9 and 21 x 9	13 x 9 and 21 x 9	11.5 x 13 (vertical)
Rated capacitance range, C_R	0.047 to 1.0 F	0.047 to 0.68 F	0.047 to 0.68 F	0.047 to 0.33 F
Tolerance on C_R at 20 °C	- 20 to + 80 %			
Rated voltage, U_R	5.5 V	6.3 V	5.5 V	5.5 V
Maximum surge voltage, U_S	6.3 V	7.0 V	6.3 V	6.3 V
Category temperature range	- 25 to + 70 °C	- 25 to + 70 °C	- 25 to + 85 °C	- 25 to + 70 °C
Useful life at U_R:				
at 85 °C	-	-	1000 hours	-
at 70 °C	1000 hours	1000 hours	2800 hours	1000 hours
at 40 °C	8000 hours	8000 hours	23 000 hours	8000 hours
at 25 °C	23 000 hours	23 000 hours	64 000 hours	23 000 hours
Shelf life at 0 V	1000 hours at upper category temperature			
Climatic category IEC 60068	25/070/21	25/070/21	25/085/21	25/070/21

SELECTION CHART FOR C_R, U_R AND FORM AT UPPER CATEGORY TEMPERATURE (UCT)				
C_R (F)	FORM	U_R = 5.5 V		U_R = 6.3 V
		UCT = 85 °C	UCT = 70 °C	UCT = 70 °C
0.047	A	13 x 9	13 x 7	13 x 9
	B	-	11.5 x 13	-
0.1	A	13 x 9	13 x 7	13 x 9
	B	-	11.5 x 13	-
0.22	A	-	13 x 7	-
	B	-	11.5 x 13	-
0.33	A	-	13 x 7	-
	B	-	11.5 x 13	-
0.47	A	21 x 9	21 x 7.5	21 x 9
	B	-	-	-
0.68	A	21 x 9	-	21 x 9
	B	-	-	-
1.0	A	-	21 x 7.5	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

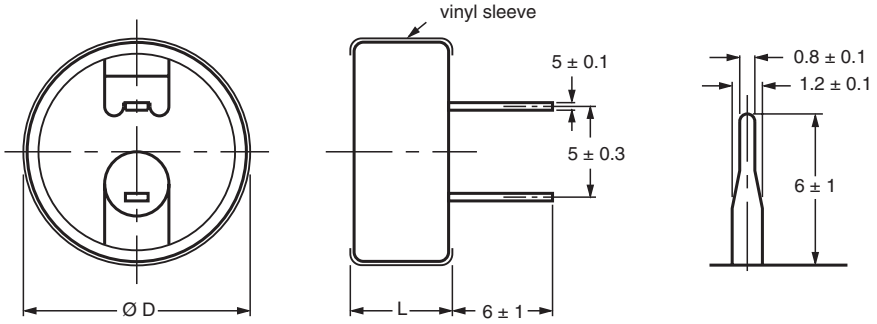


Fig.2 **FormA:** Low profile

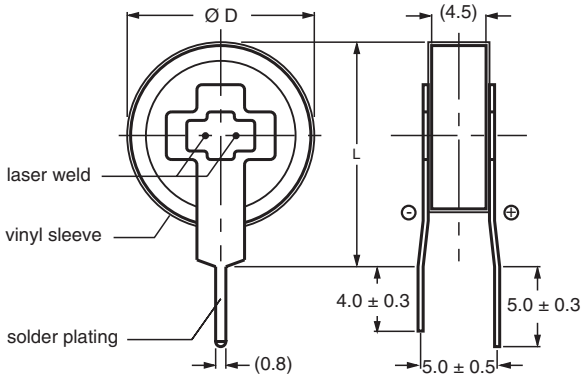


Fig.3 **Form B:** Vertical

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES						
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	FORM	Ø $D_{max.}$	$L_{max.}$	MASS (g)	PACKAGING QUANTITIES
11.5 x 13	1	B	11.8	13.5	≈ 1.5	2000
13 x 7	2	A	13.5	7.5	≈ 2.8	1000
13 x 9	3	A	13.5	9.5	≈ 3.4	1000
21 x 7.5	4	A	21.5	8.0	≈ 7.1	500
21 x 9	5	A	21.5	9.5	≈ 8.8	500

Note

Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance, tolerance - 20/+ 80 %, measured by constant current discharge method
UCT	upper category temperature
I_L	max. leakage current after 30 minutes at U_R
R_I	max. internal resistance at 1 kHz

Note

Unless otherwise specified, all electrical values in Table 1 apply at T_{amb} = 20 °C, P = 86 to 106 kPa and RH = 45 to 75 %.

ORDERING EXAMPLE

Double layer capacitor 196 series

1.0 F/5.5 V

Nominal case size: Ø 21 x 7.5 mm; Form A

Ordering code: MAL219612105E3
Former 12 NC: 2222 196 12105

Table 1

ELECTRICAL DATA AND ORDERING INFORMATION								
U_R (V)	C_R (F)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	FORM	UCT (°C)	I_L 30 min (µA)	R_I 1 kHz (Ω)	ORDERING CODE
Standard series								
5.5	0.047	13 x 7	2	A	70	69	120	MAL219612473E3
	0.1	13 x 7	2	A	70	100	75	MAL219612104E3
	0.22	13 x 7	2	A	70	135	75	MAL219612224E3
	0.33	13 x 7	2	A	70	182	75	MAL219612334E3
	0.47	21 x 7.5	4	A	70	216	30	MAL219612474E3
	1.0	21 x 7.5	4	A	70	315	30	MAL219612105E3
High temperature series								
5.5	0.047	13 x 9	3	A	85	69	300	MAL219622473E3
	0.1	13 x 9	3	A	85	100	200	MAL219622104E3
	0.47	21 x 9	5	A	85	216	50	MAL219622474E3
	0.68	21 x 9	5	A	85	260	50	MAL219622684E3
Vertical, miniaturized series								
5.5	0.047	11.5 x 13	1	B	70	69	120	MAL219632473E3
	0.1	11.5 x 13	1	B	70	100	75	MAL219632104E3
	0.22	11.5 x 13	1	B	70	135	75	MAL219632224E3
	0.33	11.5 x 13	1	B	70	182	75	MAL219632334E3
High voltage series								
6.3	0.047	13 x 9	3	A	70	69	300	MAL219613473E3
	0.1	13 x 9	3	A	70	100	200	MAL219613104E3
	0.47	21 x 9	5	A	70	216	50	MAL219613474E3
	0.68	21 x 9	5	A	70	260	50	MAL219613684E3

MEASURING OF CHARACTERISTICS

CAPACITANCE (C)

Capacitance shall be measured by constant current discharge method.

DISCHARGE CURRENT AS A FUNCTION OF RATED CAPACITANCE								
PARAMETER	VALUE							UNIT
Rated capacitance, C_R	0.047	0.1	0.22	0.33	0.47	0.68	1.0	F
Discharge current, I_D	0.1				1.0			mA

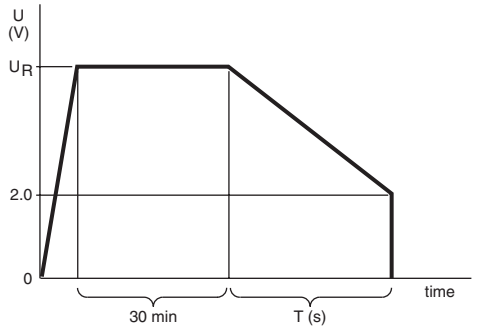


Fig.4 Voltage diagram for capacitance measurement

Capacitance value C_R is given by discharge current I_D, time T and rated voltage U_R, according to the following equation:

$$C(F) = \frac{I_D(mA) \times 10^{-3} \times T(s)}{U_R(V) - 2}$$

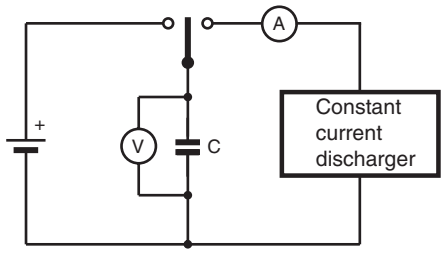


Fig.5 Test circuit for capacitance measurement

INTERNAL RESISTANCE (R_I) AT 1 kHz

$$R_I(\Omega) = \frac{V_C(V)}{10^{-3}}$$

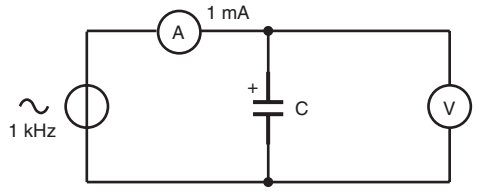


Fig.6 Test circuit for R_I measurement

LEAKAGE CURRENT (I_L)

Leakage current shall be measured after 30 minutes application of rated voltage U_R:

$$I_L(\mu A) = \frac{V(V)}{10^{-4}}$$

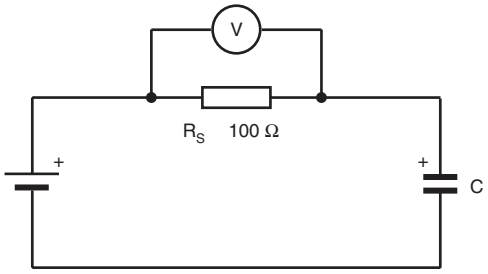


Fig.7 Test circuit for leakage current

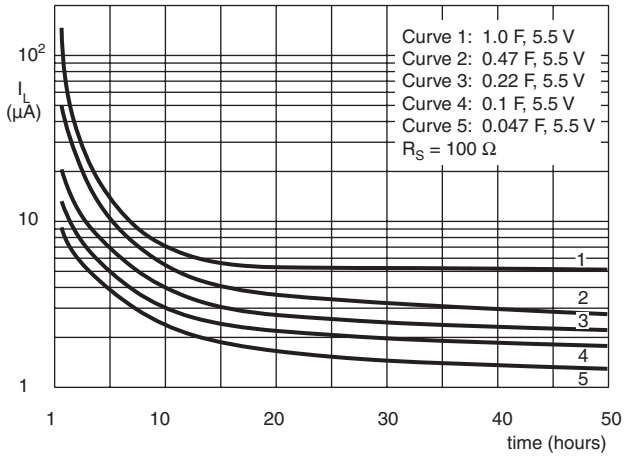


Fig.8 Typical leakage current as a function of time

DISCHARGE CHARACTERISTICS

Backup time of 196 DLC series capacitors depends on minimum memory holding voltage and discharge current (corresponding with the current consumption of the load).
For minimum backup times of standard and vertical miniaturized series see Figs 9 and 10 (charging time ≥ 24 hours).

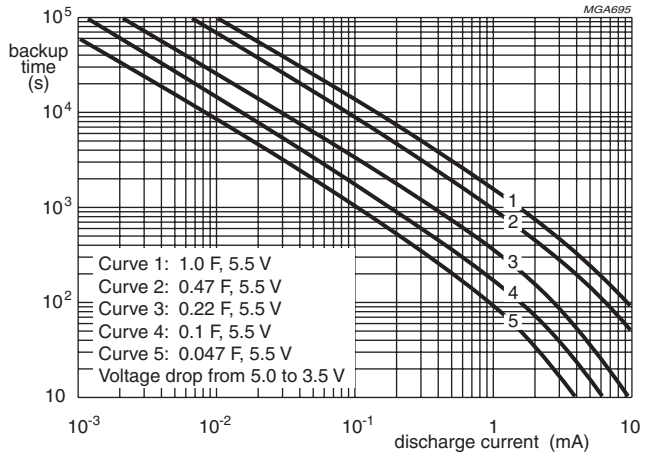


Fig.9 Typical backup time as a function of discharge current

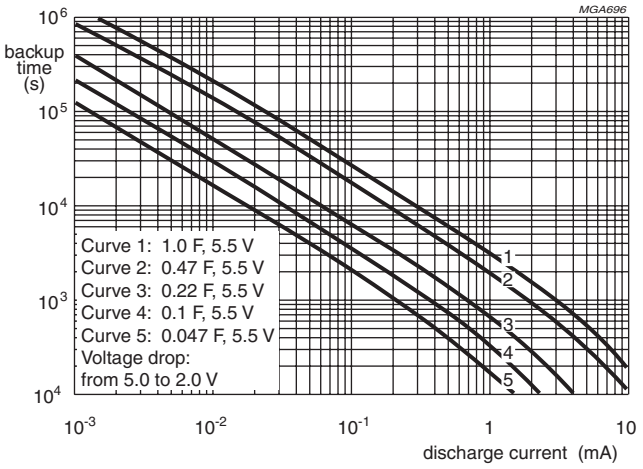


Fig.10 Typical backup time as a function of discharge current

Figure 11 shows the backup time when a 196 DLC capacitor is discharged by a constant resistance
(charging time ≥ 24 hours).

The horizontal axis shows the initial value of discharge current if 5 V is connected to the capacitor via a fixed series resistor.

EXAMPLE: 1 µA CORRESPONDS TO 5 MΩ AND 0.1 µA CORRESPONDS TO 50 MΩ

The vertical axis shows that period of time during which the voltage drops from 5 to 2 V.

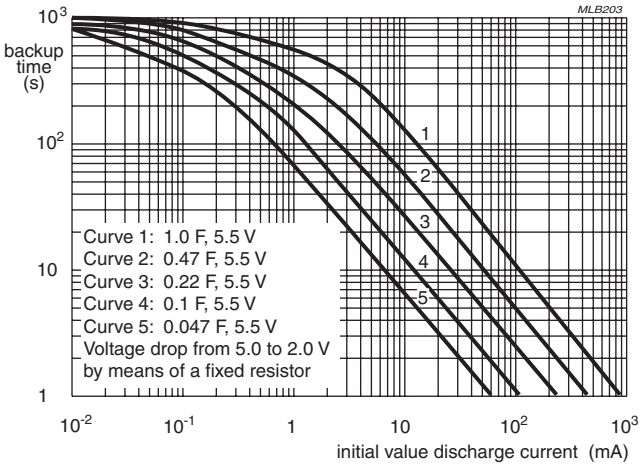


Fig.11 Typical backup time as a function of initial discharge current

Table 2

TEST PROCEDURES AND REQUIREMENTS for standard and vertical miniaturized series (5.5 V; 70 °C)			
NAME OF TEST	**IEC 60384-4/ EN130300 SUBCLAUSE**	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Robustness of terminations	4.4	tensile strength; application of loading force for 10 seconds: 20 N (standard series) 5 N (vertical miniaturized series)	no breaks
Resistance to soldering heat	4.5	solder bath; 260 °C; 5 seconds	$\Delta C/C$: ± 10 % R_I and $I_L \leq$ spec. limit
Solderability	4.6	solder bath; 235 °C; 2 seconds	≥ 75 % tinning
Vibration	4.8	10 to 55 Hz; 1.5 mm; 3 directions; 2 hours per direction	$\Delta C/C$: ± 10 % R_I and $I_L \leq$ spec. limit
Damp heat, steady state	4.12	500 hours at 55 °C; RH 90 to 95 %; no voltage applied	$\Delta C/C$: ± 30 % $R_I \leq 4$ x spec. limit $I_L \leq 2$ x spec. limit
Endurance	4.13	T_{amb} = 70 °C; 5.5 V applied; 1000 hours	$\Delta C/C$: ± 30 % $R_I \leq 4$ x spec. limit $I_L \leq 2$ x spec. limit
Storage at upper category temperature	4.17	T_{amb} = 70 °C; no voltage applied; 1000 hours	$\Delta C/C$: ± 30 % $R_I \leq 4$ x spec. limit $I_L \leq 2$ x spec. limit
Self discharge	-	24 hours storage at room temperature after application of 5 V for 1 hour	remaining voltage: ≥ 4 V
Characteristics at high and low temperature	4.19	step 1: reference measurement at + 20 °C of C, R_I and I_L step 2: measurement at - 25 °C step 3: measurement at + 20 °C step 4: measurement at + 70 °C step 5: measurement at + 20 °C	$\Delta C/C$: ± 30 % of + 20 °C value $R_I \leq 5$ x the + 20 °C value $I_L \leq 4$ x the + 20 °C value

Aluminum Capacitors
Axial, Smallest Diameter

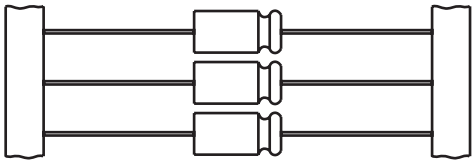
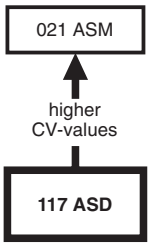


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped for automatic insertion
- Charge and discharge proof
- Ultra miniature, diameter 3.3 mm
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- General purpose, low profile and lightweight equipment
- Smoothing, filtering, buffering, decoupling, timing
- Boards with restricted mounting height

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- Series number (117)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	3.3 x 8 and 3.3 x 11
Rated capacitance range, C_R	0.47 to 22 µF
Tolerance on C_R	- 10 to + 50 % (± 20 % to special order)
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	- 40 to 85 °C
Endurance test at 85 °C	1500 hours
Useful life at 85 °C	2000 hours
Useful life at 40 °C, 1.4 I_R applied	60 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**40**	**63**
0.47	→	→	→	→	→	3.3 x 8
1.0	→	→	→	→	→	3.3 x 8
2.2	→	→	→	→	3.3 x 8	3.3 x 11
3.3	→	→	→	3.3 x 8	→	3.3 x 11
4.7	→	→	3.3 x 8	→	3.3 x 11	-
6.8	→	3.3 x 8	→	3.3 x 11	-	-
10	3.3 x 8	-	3.3 x 11	-	-	-
22	3.3 x 11	-	-	-	-	-

For technical questions, contact: aluminumcaps1@vishay.com
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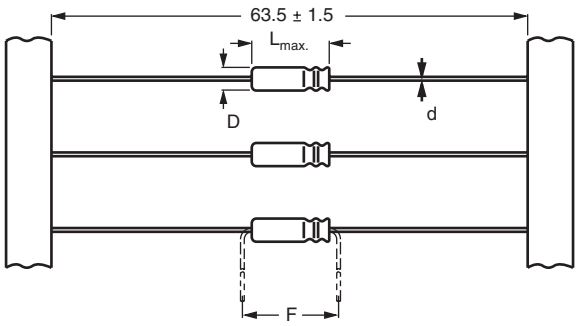
Revision: 22-Apr-08

DIMENSIONS in millimeters AND AVAILABLE FORMS



Form BR: Taped on reel
Form BA: Taped in box
Case Ø D x L = 3.3 x 8 mm and 8 x 11 mm

Fig.2 Components insulated with a blue plastic sleeve

Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE Ø D x L	CASE CODE	AXIAL: FORM BA AND BR				MASS (g)	PACKAGING QUANTITIES	
		Ø d	Ø $D_{max.}$	$L_{max.}$	$F_{min.}$		FORM BA	FORM BR
3.3 x 8	1a	0.6	3.5	9	12.5	≈ 0.3	1000	4000
3.3 x 11	1	0.6	3.5	12	15	≈ 0.35	1000	4000

Note
Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance - 10 to + 50 %
I_R	rated RMS ripple current at 100 Hz , 85 °C
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz

Note
Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

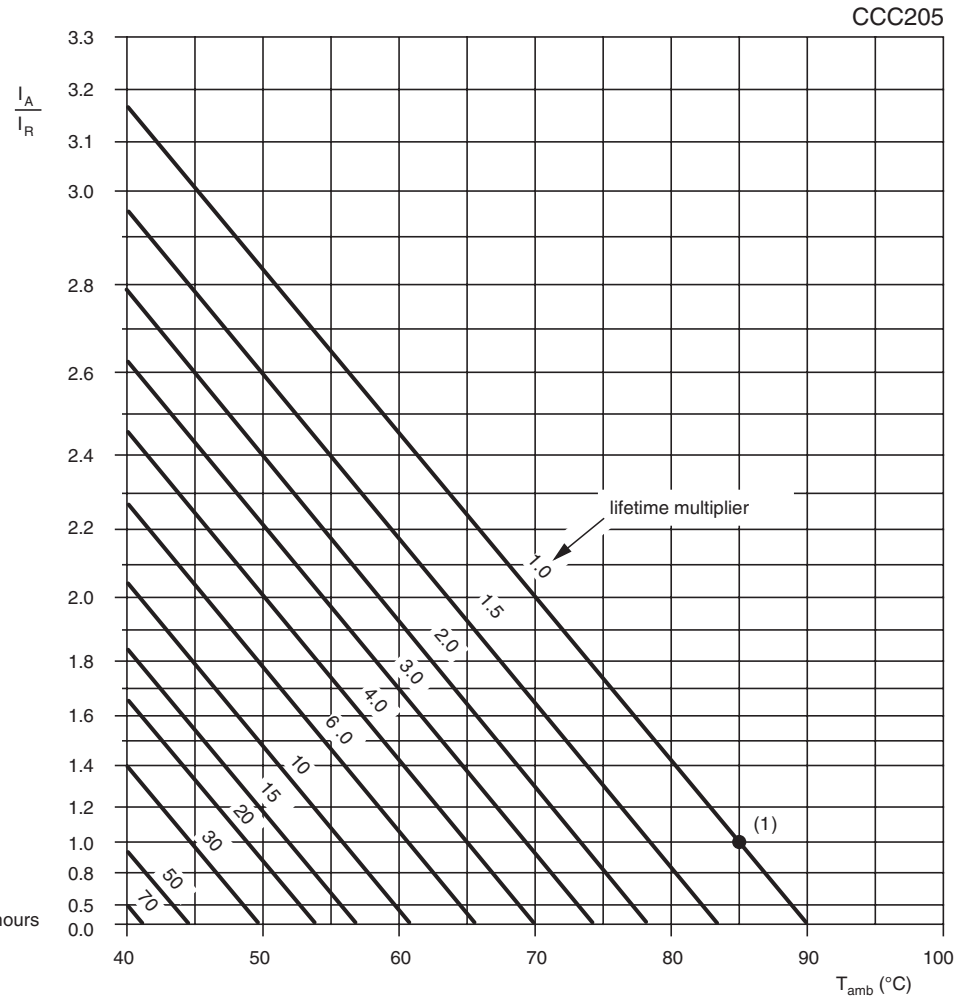
Electrolytic capacitor 117 series
10 µF/16 V; - 10/+ 50 %
Nominal case size: Ø 3.3 x 11 mm; Form BA
Former 12NC: 2222 117 35109
Ordering code: MAL211735109E3

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION								
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2117.....	
							ON REEL FORM BR	IN BOX FORM BA
6.3	10	3.3 x 8	11	3	0.30	20	23109E3	33109E3
	22	3.3 x 11	20	3	0.30	9	23229E3	33229E3
10	6.8	3.3 x 8	10	3	0.25	24	24688E3	34688E3
16	4.7	3.3 x 8	9	3	0.20	26	25478E3	35478E3
	10	3.3 x 11	16	3	0.20	12	25109E3	35109E3
25	3.3	3.3 x 8	8	3	0.18	27	26338E3	36338E3
	6.8	3.3 x 11	14	3	0.18	13	26688E3	36688E3
40	2.2	3.3 x 8	7	3	0.16	32	27228E3	37228E3
	4.7	3.3 x 11	13	3	0.16	15	27478E3	37478E3
63	0.47	3.3 x 8	4	3	0.10	120	28477E3	38477E3
	1	3.3 x 8	6	3	0.12	55	28108E3	38108E3
	2.2	3.3 x 11	11	3	0.14	25	28228E3	38228E3
	3.3	3.3 x 11	13	3	0.14	17	28338E3	38338E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$
Inductance		
Equivalent series inductance (ESL)	Case Ø D x L = 3.3 x 8 mm	typ. 13 nH
	Case Ø D x L = 3.3 x 11 mm	typ. 15 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz

I_R = rated ripple current at 100 Hz, 85 °C

(1) Useful life at 85 °C and IR applied: 2000 hours

Fig.3 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 16 V	U_R = 25 to 40 V	U_R = 63 V
50	0.80	0.75	0.70
100	1.00	1.00	1.00
300	1.20	1.30	1.55
1000	1.35	1.55	1.90
3000	1.45	1.70	2.30
≥ 10 000	1.50	1.80	2.50

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; 1500 hours	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 2000 hours	ΔC/C: ± 50 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_{L5} ≤ 2 x spec. limit

Aluminum Capacitors
Axial Standard Miniature

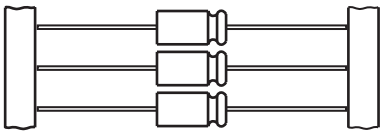
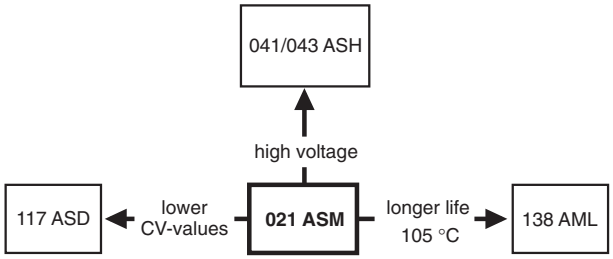


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS
COMPLIANT

APPLICATIONS

- General purpose, industrial, automotive, audio-video
- Coupling, decoupling, smoothing, filtering, buffering
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration and shock resistant

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (85 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- "+" sign to identify the positive terminal (not for case sizes L < 18 mm)
- Series number (021)

QUICK REFERENCE DATA

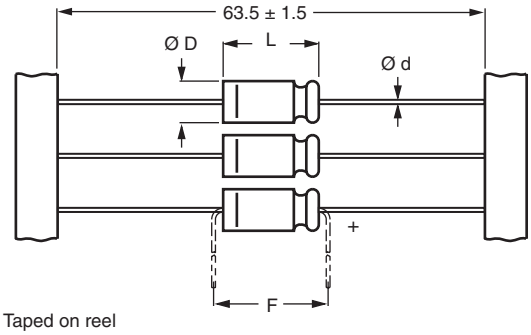
DESCRIPTION	VALUE	
Nominal case sizes (Ø D x L in mm)	4.5 x 10 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	0.47 to 15 000 µF	
Tolerance on C_R	± 20 %	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	- 40 to + 85 °C	
Endurance test at 85 °C:		
U_R = 6.3 to 25 V	1000 hours	5000 hours
U_R = 40 to 100 V	2000 hours	5000 hours
Endurance test at 105 °C	-	2000 hours
Useful life at 85 °C	2500 hours	8000 hours
Useful life at 40 °C, 1.4 x IR applied	70 000 hours	200 000 hours
Shelf life at 0 V, 85 °C	500 hours	500 hours
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/56	

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)						
	6.3	10	16	25	40	63	100
0.47	-	-	-	-	-	4.5 x 10	-
1.0	-	-	-	-	-	4.5 x 10	4.5 x 10
2.2	-	-	-	-	-	4.5 x 10	4.5 x 10
3.3	-	-	-	-	-	4.5 x 10	-
4.7	-	-	-	-	-	4.5 x 10	4.5 x 10
10	-	-	-	-	-	4.5 x 10	6 x 10
15	-	-	-	-	-	4.5 x 10	8 x 11
	-	-	-	-	-	-	6.5 x 18
22	-	-	-	-	4.5 x 10	6 x 10	8 x 11
	-	-	-	-	-	-	6.5 x 18
33	-	-	-	-	-	6 x 10	6.5 x 18

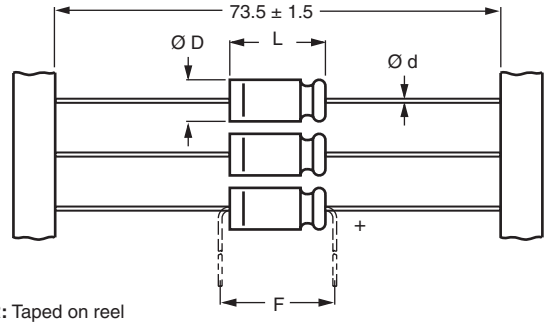
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
C_R (µF)	U_R (V)						
	6.3	**10**	**16**	**25**	**40**	**63**	**100**
47	-	-	-	4.5 x 10	6 x 10	8 x 11	8 x 18
	-	-	-	-	-	6.5 x 18	-
68	-	-	4.5 x 10	-	-	8 x 11	10 x 18
	-	-	-	-	-	6.5 x 18	-
100	-	4.5 x 10	-	6 x 10	8 x 11	8 x 18	10 x 25
	-	-	-	-	6.5 x 18	-	10 x 30
150	-	-	6 x 10	8 x 11	8 x 18	10 x 18	12.5 x 30
	-	-	-	6.5 x 18	-	-	-
220	-	6 x 10	8 x 11	6.5 x 18	10 x 18	10 x 25	12.5 x 30
	-	-	-	-	-	10 x 30	-
330	-	8 x 11	6.5 x 18	8 x 18	10 x 25	12.5 x 30	15 x 30
470	8 x 11	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30	18 x 30
	-	-	-	-	10 x 30	-	-
680	-	8 x 18	10 x 18	10 x 25	12.5 x 30	15 x 30	18 x 38
	-	-	-	10 x 30	-	-	-
1000	8 x 18	10 x 18	10 x 25	12.5 x 30	12.5 x 30	18 x 30	21 x 38
	-	-	10 x 30	-	-	-	-
1500	-	10 x 25	12.5 x 30	12.5 x 30	15 x 30	18 x 38	-
	-	10 x 30	-	-	-	-	-
2200	10 x 25	12.5 x 30	12.5 x 30	15 x 30	18 x 30	21 x 38	-
3300	-	12.5 x 30	15 x 30	18 x 30	18 x 38	-	-
4700	-	15 x 30	18 x 30	18 x 38	21 x 38	-	-
6800	-	18 x 30	18 x 38	21 x 38	-	-	-
10 000	-	18 x 38	21 x 38	-	-	-	-
15 000	-	21 x 38	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



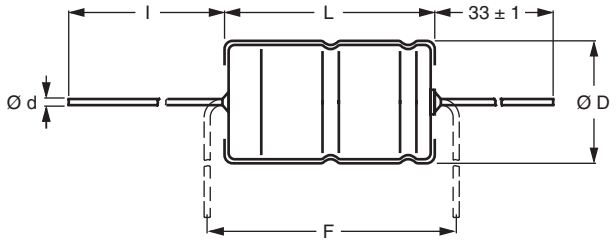
Form BR: Taped on reel
Form BA: Taped in box (ammopack)
Case Ø D x L = 4.5 x 10 to 8 x 11 mm

Fig.2 **Forms BA and BR**



Form BR: Taped on reel
Case Ø D x L = 6.5 x 18 to 15 x 30 mm
Form BA: Taped in box (ammopack)
Case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.3 **Forms BA and BR**



Form AA: Axial in box
Case Ø D x L = 10 x 30 to 21 x 38 mm

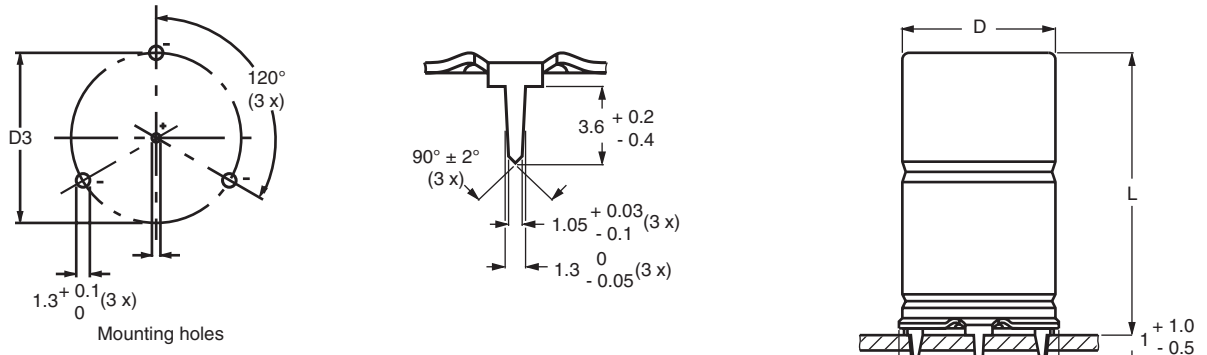
Fig.4 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**										
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**AXIAL: FORM AA, BA, and BR**					**MASS (g)**	**PACKAGING QUANTITIES**		
		Ø d	**l**	**Ø $D_{max.}$**	**$L_{max.}$**	**$F_{min.}$**		**FORM AA**	**FORM BA**	**FORM BR**
4.5 x 10	2	0.6	-	5.0	10.5	15	≈ 0.50	-	1000	3000
6 x 10	3	0.6	-	6.3	10.5	15	≈ 0.70	-	1000	1000
8 x 11	5a	0.6	-	8.5	11.5	15	≈ 1.1	-	500	500
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note

Detailed tape dimensions see section ‘PACKAGING’.



Form MR:
Case Ø D x L = 15 x 30 to 21 x 38 mm
Case not insulated (insulation on request)
Especially for applications with severe shocks and vibrations

Fig.5 Mounting hole diagramm and outline. **Form MR:** with mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**MOUNTING RING: FORM MR**					**MASS (g)**	**PACKAGING QUANTITIES**
		Ø d1	**Ø d2**	**Ø $D2_{max.}$**	**D3**	**$L_{max.}$**		
15 x 30	02	0.8	1.0 + 0.4	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 x 30	03	0.8	1.0 + 0.4	19.5	18.5 ± 0.2	33	≈ 12.9	240
18 x 38	04	0.8	1.0 + 0.4	19.5	18.5 ± 0.2	42	≈ 19.0	100
21 x 38	05	0.8	1.0 + 0.4	22.5	21.5 ± 0.2	42	≈ 24.0	100

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L5}	max. leakage current after 5 min at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 021 series

1000 µF/16 V; ± 20 %

Nominal case size: Ø 10 x 25 mm; Form BA

Ordering code: MAL202190518E3
Former 12 NC: 2222 021 90518

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION

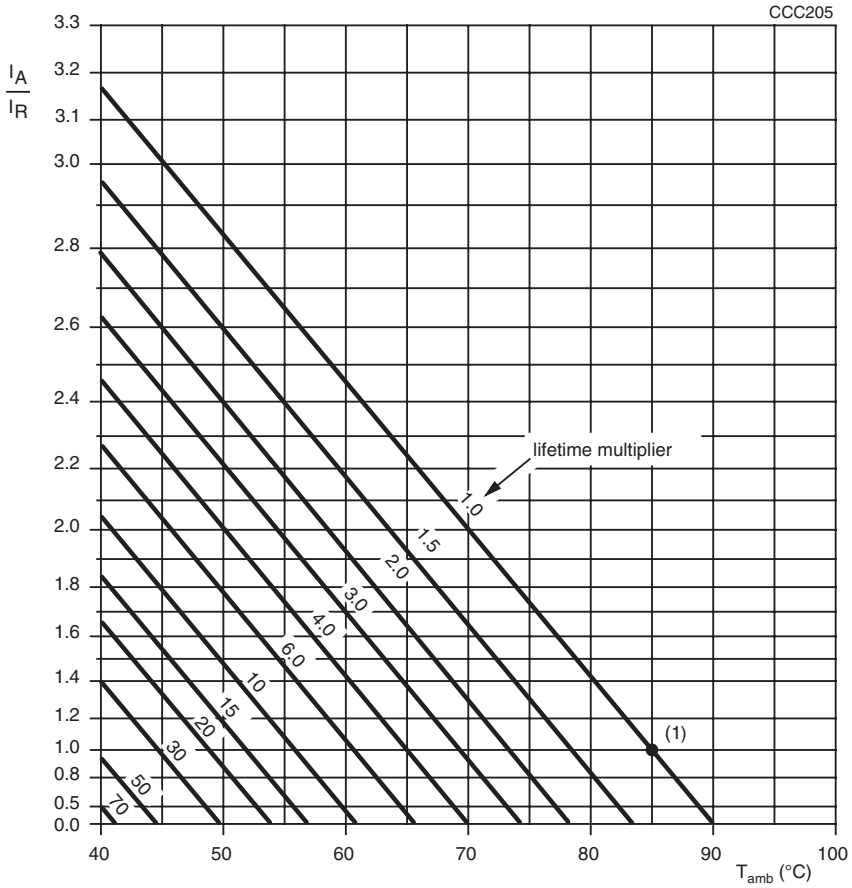
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2021			
								IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
6.3	470	8 x 11	260	10	0.25	0.85	0.64	-	23471E3	33471E3	-
	1000	8 x 18	440	17	0.25	0.4	0.5	-	23102E3	33102E3	-
	2200	10 x 25	710	32	0.29	0.21	0.16	-	90588E3	90589E3	-
10	100	4.5 x 10	100	6	0.20	3.2	2.0	-	24101E3	34101E3	-
	220	6 x 10	160	8.4	0.20	1.5	0.91	-	24221E3	34221E3	-
	330	8 x 11	230	11	0.20	1.0	0.61	-	24331E3	34331E3	-
	470	6.5 x 18	310	13	0.20	0.68	0.43	-	24471E3	34471E3	-
	680	8 x 18	400	18	0.20	0.47	0.29	-	24681E3	34681E3	-
	1000	10 x 18	550	24	0.20	0.32	0.20	-	24102E3	34102E3	-
	1500	10 x 25	690	34	0.23	0.25	0.18	-	90524E3	90525E3	-
	1500	10 x 30	740	34	0.23	0.245	0.18	14152E3	24152E3	-	-
	2200	12.5 x 30	980	48	0.25	0.177	0.095	14222E3	24222E3	-	-
	3300	12.5 x 30	1090	70	0.27	0.128	0.095	14332E3	24332E3	-	-
	4700	15 x 30	1320	98	0.29	0.100	0.07	14472E3	24472E3	-	44472E3
	6800	18 x 30	1590	140	0.34	0.079	0.065	14682E3	-	-	44682E3
	10 000	18 x 38	2090	204	0.40	0.064	0.04	14103E3	-	-	44103E3
	15 000	21 x 38	2250	304	0.50	0.054	0.035	14153E3	-	-	44153E3
16	68	4.5 x 10	90	6.2	0.16	3.8	2.4	-	25689E3	35689E3	-
	150	6 x 10	140	8.8	0.16	1.7	1.1	-	25151E3	35151E3	-
	220	8 x 11	210	11	0.16	1.2	0.73	-	25221E3	35221E3	-
	330	6.5 x 18	290	15	0.16	0.77	0.48	-	25331E3	35331E3	-
	470	8 x 18	380	19	0.16	0.55	0.34	-	25471E3	35471E3	-
	680	10 x 18	500	26	0.16	0.38	0.24	-	25681E3	35681E3	-
	1000	10 x 25	660	36	0.16	0.26	0.18	-	90517E3	90518E3	-
	1000	10 x 30	700	36	0.16	0.260	0.175	15102E3	25102E3	-	-
	1500	12.5 x 30	950	52	0.19	0.205	0.095	15152E3	25152E3	-	-
	2200	12.5 x 30	1040	74	0.21	0.150	0.095	15222E3	25222E3	-	-
	3300	15 x 30	1290	110	0.23	0.111	0.07	15332E3	25332E3	-	45332E3
	4700	18 x 30	1560	154	0.25	0.087	0.065	15472E3	-	-	45472E3
	6800	18 x 38	2040	222	0.30	0.070	0.04	15682E3	-	-	45682E3
	10 000	21 x 38	2170	324	0.36	0.058	0.035	15103E3	-	-	45103E3
25	47	4.5 x 10	80	6.4	0.14	4.8	2.6	-	26479E3	36479E3	-
	100	6 x 10	150	9	0.14	2.3	1.2	-	26101E3	36101E3	-
	150	8 x 11	190	12	0.14	1.5	0.80	-	90534E3	90535E3	-
	150	6.5 x 18	210	12	0.14	1.5	0.80	-	26151E3	36151E3	-
	220	6.5 x 18	250	15	0.14	1.0	0.55	-	26221E3	36221E3	-
	330	8 x 18	340	21	0.14	0.68	0.36	-	26331E3	36331E3	-
	470	10 x 18	450	28	0.14	0.48	0.26	-	26471E3	36471E3	-
	680	10 x 25	560	38	0.14	0.33	0.18	-	90527E3	90528E3	-
	680	10 x 30	640	38	0.14	0.323	0.175	16681E3	26681E3	-	-
	1000	12.5 x 30	840	54	0.14	0.220	0.095	16102E3	26102E3	-	-
	1500	12.5 x 30	950	79	0.17	0.179	0.095	16152E3	26152E3	-	-

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2021			
								IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
25	2200	15 x 30	1180	114	0.19	0.132	0.07	16222E3	26222E3	-	46222E3
	3300	18 x 30	1470	169	0.21	0.099	0.065	16332E3	-	-	46332E3
	4700	18 x 38	1920	239	0.23	0.079	0.04	90062E3	-	-	46472E3
	6800	21 x 38	2070	344	0.28	0.064	0.035	16682E3	-	-	46682E3
40	22	4.5 x 10	60	5.8	0.11	8.0	3.2	-	27229E3	37229E3	-
	47	6 x 10	110	7.8	0.11	3.8	1.5	-	27479E3	37479E3	-
	100	8 x 11	170	12	0.11	1.8	0.70	-	90537E3	90538E3	-
	100	6.5 x 18	190	12	0.11	1.8	0.70	-	27101E3	37101E3	-
	150	8 x 18	250	16	0.11	1.1	0.47	-	27151E3	37151E3	-
	220	10 x 18	330	22	0.11	0.8	0.32	-	27221E3	37221E3	-
	330	10 x 25	430	30	0.11	0.53	0.21	-	27331E3	37331E3	-
	470	10 x 25	520	42	0.11	0.37	0.18	-	90514E3	90515E3	-
	470	10 x 30	590	42	0.12	0.404	0.175	17471E3	27471E3	-	-
	680	12.5 x 30	800	58	0.12	0.297	0.110	17681E3	27681E3	-	-
	1000	12.5 x 30	900	84	0.12	0.190	0.110	17102E3	90064E3	-	-
	1500	15 x 30	1120	124	0.15	0.159	0.07	17152E3	27152E3	-	47152E3
	2200	18 x 30	1390	180	0.17	0.118	0.065	17222E3	-	-	47222E3
	3300	18 x 38	1810	268	0.19	0.090	0.04	17332E3	-	-	47332E3
	4700	21 x 38	1940	380	0.21	0.072	0.035	17472E3	-	-	47472E3
63	0.47	4.5 x 10	8	4.1	0.09	310	120	-	28477E3	38477E3	-
	1	4.5 x 10	12	4.1	0.09	150	55	-	28108E3	38108E3	-
	2.2	4.5 x 10	21	4.3	0.09	65	25	-	28228E3	38228E3	-
	3.3	4.5 x 10	25	4.4	0.09	44	17	-	28338E3	38338E3	-
	4.7	4.5 x 10	31	4.6	0.09	31	12	-	28478E3	38478E3	-
	10	4.5 x 10	50	5.3	0.08	13	5.5	-	28109E3	38109E3	-
	15	4.5 x 10	55	5.9	0.08	8.5	3.7	-	28159E3	38159E3	-
	22	6 x 10	90	6.8	0.08	5.8	2.5	-	28229E3	38229E3	-
	33	6 x 10	100	8.2	0.08	3.9	1.7	-	28339E3	38339E3	-
	47	8 x 11	140	10	0.08	2.7	1.2	-	90541E3	90542E3	-
	47	6.5 x 18	150	10	0.08	2.7	1.2	-	28479E3	38479E3	-
	68	8 x 11	160	13	0.08	1.9	0.81	-	90544E3	90545E3	-
	68	6.5 x 18	170	13	0.08	1.9	0.81	-	28689E3	38689E3	-
	100	8 x 18	250	17	0.08	1.3	0.55	-	28101E3	38101E3	-
	150	10 x 18	320	23	0.08	0.85	0.37	-	28151E3	38151E3	-
	220	10 x 25	430	32	0.08	0.60	0.25	-	90511E3	90512E3	-
	220	10 x 30	480	32	0.08	0.614	0.26	18221E3	28221E3	-	-
	330	12.5 x 30	610	46	0.08	0.409	0.19	18331E3	28331E3	-	-
	470	12.5 x 30	700	63	0.08	0.287	0.13	18471E3	28471E3	-	-
	680	15 x 30	890	90	0.08	0.199	0.095	18681E3	28681E3	-	48681E3
	1000	18 x 30	1170	130	0.08	0.135	0.075	18102E3	-	-	48102E3
	1500	18 x 38	1530	193	0.11	0.122	0.045	18152E3	-	-	48152E3
	2200	21 x 38	1780	281	0.13	0.099	0.040	18222E3	-	-	48222E3
100	1	4.5 x 10	14	4.2	0.08	130	90	-	29108E3	39108E3	-
	2.2	4.5 x 10	20	4.4	0.08	58	41	-	29228E3	39228E3	-
	4.7	4.5 x 10	30	4.9	0.08	27	19	-	29478E3	39478E3	-
	10	6 x 10	65	6	0.08	13	9	-	29109E3	39109E3	-
	15	8 x 11	77	7	0.08	8.5	6	-	90547E3	90548E3	-
	15	6.5 x 18	85	7	0.08	8.5	6	-	29159E3	39159E3	-
	22	8 x 11	95	8.4	0.08	5.8	4.1	-	90551E3	90552E3	-
	22	6.5 x 18	100	8.4	0.08	5.8	4.1	-	29229E3	39229E3	-
	33	6.5 x 18	120	10.6	0.08	3.9	2.7	-	29339E3	39339E3	-
	47	8 x 18	160	13.4	0.08	2.7	1.9	-	29479E3	39479E3	-
	68	10 x 18	220	17.6	0.08	1.9	1.3	-	29689E3	39689E3	-
	100	10 x 25	300	24	0.08	1.3	0.9	-	90531E3	90532E3	-
	100	10 x 30	340	24	0.07	1.150	1.0	19101E3	29101E3	-	-
	150	12.5 x 30	490	34	0.07	0.645	0.61	19151E3	29151E3	-	-
	220	12.5 x 30	560	48	0.08	0.610	0.56	19221E3	29221E3	-	-
	330	15 x 30	740	70	0.09	0.420	0.40	19331E3	29331E3	-	49331E3
	470	18 x 30	980	98	0.09	0.310	0.29	19471E3	-	-	49471E3
	680	18 x 38	1260	140	0.09	0.195	0.18	19681E3	-	-	49681E3
	1000	21 x 38	1470	204	0.10	0.160	0.15	19102E3	-	-	49102E3

ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$	
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$	
Inductance			
Equivalent series inductance (ESL)	Case Ø D x L mm:		
	4.5 x 10	typ. 10 nH	-
	6 x 10	typ. 22 nH	-
	8 x 11	typ. 85 nH	-
	6.5 x 18	typ. 25 nH	-
	8 x 18	typ. 40 nH	-
	10 x 18	typ. 61 nH	-
	10 x 25	typ. 38 nH	-
	10 x 30	typ. 38 nH	-
	12.5 x 30	typ. 46 nH	-
	15 x 30	typ. 48 nH	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

RIPPLE CURRENT AND USEFUL LIFE



I_A = Actual ripple current at 100 Hz
I_R = Rated ripple current at 100 Hz, 85 °C

(1) Useful life at 85 °C and I_R applied:
Case Ø D x L = 4.5 x 10 to 10 x 25 mm: 2500 hours
Case Ø D x L = 10 x 30 to 21 x 38 mm: 8000 hours

Fig.6 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	**I_R MULTIPLIER**		
	U_R = 6.3 to 16 V	**U_R = 25 to 40 V**	**U_R = 63 to 100 V**
50	0.95	0.90	0.85
100	1.00	1.00	1.00
300	1.07	1.12	1.20
1000	1.12	1.20	1.30
3000	1.15	1.25	1.35
≥ 10 000	1.20	1.30	1.40

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; case Ø D x L = 4.5 x 10 to 10 x 25 mm: U_R = 6.3 to 25 V: 1000 hours; U_R = 40 to 100 V: 2000 hours; case Ø D x L = 10 x 30 to 21 x 38 mm: U_R = 6.3 to 100 V: 5000 hours	$U_R \leq 6.3$ V; ΔC/C: + 15/- 30 % $U_R > 6.3$ V; ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
		T_{amb} = 105 °C; U_R applied; case Ø D x L = 10 x 30 to 21 x 38 mm: 2000 hours	ΔC/C: ≤ ± 20 % tan δ ≤ 1.6 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; case Ø D x L = 4.5 x 10 to 10 x 25 mm: 2500 hours; case Ø D x L = 10 x 30 to 21 x 38 mm: 8000 hours	$U_R \leq 6.3$ V; ΔC/C: + 45/- 50 % $U_R > 6.3$ V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 min, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_{L5} ≤ 2 x spec. limit

Aluminum Capacitors
Axial Standard

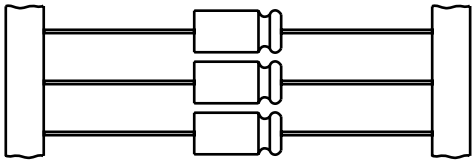
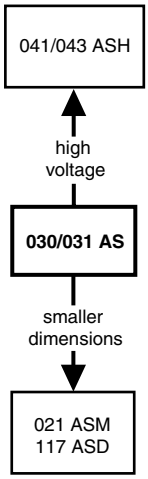


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped version available for automatic insertion
- Charge and discharge proof
- Useful life: 3000 hours at 85 °C (case Ø D = 3.3 mm: 1500 hours)
- Standard dimensions
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- General purpose and industrial, automotive, telecommunication, audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Boards with restricted mounting height, vibration and shock resistant

MARKING

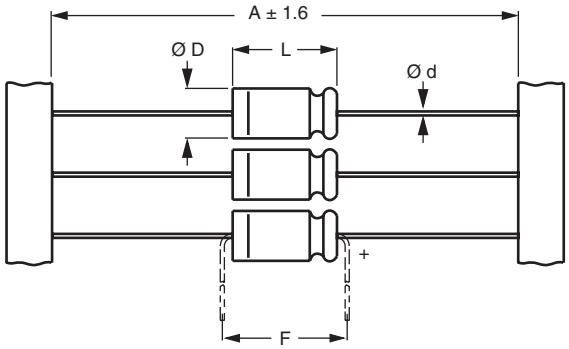
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for - 10 to + 50 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal (not for case sizes L < 18 mm)
- Series number (030 or 031)

QUICK REFERENCE DATA		
DESCRIPTION	**VALUE**	
Nominal case sizes (Ø D x L in mm)	3.3 x 11	4.5 x 10 to 10 x 25
Rated capacitance range, C_R	0.47 to 1000 µF	
Tolerance on C_R	- 10 to + 50 %	
Rated voltage, U_R	6.3 to 100 V	
Category temperature range	- 40 to + 85 °C	
Endurance test at 85 °C	1000 hours	2000 hours
Useful life at 85 °C	1500 hours	3000 hours
Useful life at 40 °C, 1.4 x I_R applied	40 000 hours	80 000 hours
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/56	

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
C_R (µF)	U_R (V)						
	6.3	**10**	**16**	**25**	**40**	**63**	**100**
0.47	-	-	-	-	-	-	4.5 x 10
1.0	-	-	-	-	-	4.5 x 10	4.5 x 10
	-	-	-	-	-	3.3 x 11	-
2.2	-	-	-	-	3.3 x 11	4.5 x 10	4.5 x 10
3.3	-	-	-	-	-	4.5 x 10	4.5 x 10
4.7	-	-	3.3 x 11	-	-	4.5 x 10	6 x 10
6.8	-	-	-	-	-	4.5 x 10	6 x 10
10	3.3 x 11	-	-	4.5 x 10	4.5 x 10	6 x 10	8 x 11
	-	-	-	-	-	-	6.5 x 18
15	-	-	-	-	4.5 x 10	6 x 10	-
22	-	-	-	4.5 x 10	6 x 10	8 x 11	8 x 18
	-	-	-	-	-	6.5 x 18	-
33	-	-	4.5 x 10	-	6 x 10	-	10 x 18
47	-	4.5 x 10	-	6 x 10	8 x 11	8 x 18	10 x 25
	-	-	-	-	6.5 x 18	-	-
68	4.5 x 10	-	6 x 10	-	-	10 x 18	-
100	-	6 x 10	-	8 x 11	8 x 18	10 x 25	-
	-	-	-	6.5 x 18	-	-	-
150	6 x 10	-	8 x 11	8 x 18	10 x 18	-	-
	-	-	6.5 x 18	-	-	-	-
220	-	8 x 11	8 x 18	10 x 18	10 x 25	-	-
	-	6.5 x 18	-	-	-	-	-
330	-	8 x 18	10 x 18	10 x 25	-	-	-
470	8 x 18	10 x 18	10 x 25	-	-	-	-
680	10 x 18	10 x 25	-	-	-	-	-
1000	10 x 25	-	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS



Dimensional outline

Fig.2 **Form BR:** Taped on reel, non-preferred

Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**AXIAL FORM BA and BR**					**MASS (g)**	**PACKAGING QUANTITIES**	
		Ø d	**A**	**Ø $D_{max.}$**	**$L_{max.}$**	**$F_{min.}$**		**FORM BA**	**FORM BR**
3.3 x 11	1	0.6	63.5 ± 1.5	3.5	12	17.5	≈ 0.35	1000	4000
4.5 x 10	2	0.6	63.5 ± 1.5	5.0	10.5	15	≈ 0.5	1000	3000
6 x 10	3	0.6	63.5 ± 1.5	6.3	10.5	15	≈ 0.7	1000	1000
8 x 11	5a	0.6	63.5 ± 1.5	8.5	11.5	15	≈ 1.1	500	500
6.5 x 18	4	0.8	73 ± 1.6	6.9	18.5	25	≈ 1.3	1000	1000
8 x 18	5	0.8	73 ± 1.6	8.5	18.5	25	≈ 1.7	500	500
10 x 18	6	0.8	73 ± 1.6	10.5	18.5	25	≈ 2.5	500	500
10 x 25	7	0.8	73 ± 1.6	10.5	25.0	30	≈ 3.3	500	500

Note

Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance - 10 to + 50 %
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 031 series

330 µF/10 V; - 10/+ 50 %

Nominal case size: Ø 8 x 18 mm; Form BA

Ordering code: MAL203134331E3
Former 12 NC: 2222 031 34331

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2.....	
										TAPED ON REEL FORM BR	TAPED IN BOX FORM BA
6.3	10	3.3 x 11	1	15	5	5.1	0.30	47.8	20	03023109E3	03033109E3
	68	4.5 x 10	2	75	22	5.9	0.25	5.86	2.9	03023689E3	03033689E3
	150	6 x 10	3	120	10	6.9	0.25	2.66	1.3	03023151E3	03033151E3
	470	8 x 18	5	330	22	11	0.25	0.85	0.43	03123471E3	03133471E3
	680	10 x 18	6	430	30	14	0.25	0.59	0.29	03123681E3	03133681E3
	1000	10 x 25	7	560	42	18	0.25	0.40	0.20	03123102E3	03133102E3
10	47	4.5 x 10	2	70	24	5.9	0.20	6.78	3.4	03024479E3	03034479E3
	100	6 x 10	3	110	10	7.0	0.20	3.19	1.6	03024101E3	03034101E3
	220	8 x 11	5a	210	18	9.4	0.20	1.45	0.73	03124221E3	03034221E3
	220	6.5 x 18	4	210	18	9.4	0.20	1.45	0.73	03124221E3	03134221E3
	330	8 x 18	5	310	24	12	0.20	0.97	0.48	03124331E3	03134331E3
	470	10 x 18	6	410	33	14	0.20	0.68	0.34	03124471E3	03134471E3
	680	10 x 25	7	510	45	19	0.20	0.47	0.24	03124681E3	03134681E3
16	4.7	3.3 x 11	1	15	5	5.1	0.20	67.8	26	03025478E3	03035478E3
	33	4.5 x 10	2	65	27	6.1	0.16	7.72	3.6	03025339E3	03035339E3
	68	6 x 10	3	110	11	7.2	0.16	3.75	1.8	03025689E3	03035689E3
	150	8 x 11	5a	200	19	9.8	0.16	1.70	0.80	03025151E3	03035151E3
	150	6.5 x 18	4	200	19	9.8	0.16	1.70	0.80	03125151E3	03135151E3
	220	8 x 18	5	270	26	12	0.16	1.16	0.55	03125221E3	03135221E3
	330	10 x 18	6	410	36	16	0.16	0.78	0.36	03125331E3	03135331E3
	470	10 x 25	7	480	49	20	0.16	0.55	0.26	03125471E3	03135471E3
25	10	4.5 x 10	2	50	13	5.5	0.14	22.3	9	03026109E3	03036109E3
	22	4.5 x 10	2	60	28	6.1	0.14	10.2	4.1	03026229E3	03036229E3
	47	6 x 10	3	100	12	7.4	0.14	4.8	1.9	03026479E3	03036479E3
	100	8 x 11	5a	160	19	10	0.14	2.23	0.90	03026101E3	03036101E3
	100	6.5 x 18	4	160	19	10	0.14	2.23	0.90	03126101E3	03136101E3
	150	8 x 18	5	240	27	13	0.14	1.49	0.60	03126151E3	03136151E3
	220	10 x 18	6	350	37	16	0.14	1.02	0.41	03126221E3	03136221E3
	330	10 x 25	7	460	54	22	0.14	0.68	0.27	03126331E3	03136331E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2.....	
										TAPED ON REEL FORM BR	TAPED IN BOX FORM BA
40	2.2	3.3 x 11	1	15	5	5.1	0.15	109	32	03027228E3	03037228E3
	10	4.5 x 10	2	50	20	5.8	0.11	17.6	7	03027109E3	03037109E3
	15	4.5 x 10	2	55	30	6.2	0.11	11.7	4.7	03027159E3	03037159E3
	22	6 x 10	3	75	9	6.8	0.11	8.0	3.2	03027229E3	03037229E3
	33	6 x 10	3	95	12	7.7	0.11	5.31	2.1	03027339E3	03037339E3
	47	8 x 11	5a	150	16	8.8	0.11	3.73	1.5	03027479E3	03037479E3
	47	6.5 x 18	4	150	16	8.8	0.11	3.73	1.5	03127479E3	03137479E3
	100	8 x 18	5	220	28	13	0.11	1.75	0.70	03127101E3	03137101E3
	150	10 x 18	6	300	40	17	0.11	1.17	0.47	03127151E3	03137151E3
	220	10 x 25	7	430	57	23	0.11	0.80	0.32	03127221E3	03137221E3
63	1.0	3.3 x 11	1	10	5	5.1	0.12	191	55	03090067E3	03090068E3
	1.0	4.5 x 10	2	13	5	5.1	0.09	143	55	03028108E3	03038108E3
	2.2	4.5 x 10	2	25	7	5.3	0.09	65.2	25	03028228E3	03038228E3
	3.3	4.5 x 10	2	35	11	5.4	0.09	46.5	17	03028338E3	03038338E3
	4.7	4.5 x 10	2	40	15	5.6	0.09	30.5	12	03028478E3	03038478E3
	6.8	4.5 x 10	2	46	22	5.9	0.09	21.1	8.1	03028688E3	03038688E3
	10	6 x 10	3	70	7	6.3	0.08	12.8	5.5	03028109E3	03038109E3
	15	6 x 10	3	79	10	6.9	0.08	8.5	3.7	03028159E3	03038159E3
	22	8 x 11	5a	110	13	7.8	0.08	5.79	2.5	03028229E3	03038229E3
	22	6.5 x 18	4	110	13	7.8	0.08	5.79	2.5	03128229E3	03138229E3
	47	8 x 18	5	190	22	11	0.08	2.71	1.2	03128479E3	03138479E3
	68	10 x 18	6	250	30	14	0.08	1.88	0.81	03128689E3	03138689E3
	100	10 x 25	7	300	42	18	0.08	1.28	0.55	03128101E3	03138101E3
100	0.47	4.5 x 10	2	9	5	4.3	0.08	271	96	03029477E3	03039477E3
	1.0	4.5 x 10	2	20	5	4.6	0.08	128	45	03029108E3	03039108E3
	2.2	4.5 x 10	2	30	11	5.3	0.08	57.9	21	03029228E3	03039228E3
	3.3	4.5 x 10	2	40	17	6.0	0.08	38.6	14	03029338E3	03039338E3
	4.7	6 x 10	3	50	13	6.8	0.07	23.7	9.6	03029478E3	03039478E3
	6.8	6 x 10	3	70	18	8.0	0.07	16.4	6.6	03029688E3	03039688E3
	10	8 x 11	5a	90	24	10	0.07	11.2	4.5	03029109E3	03039109E3
	10	6.5 x 18	4	90	24	10	0.07	11.2	4.5	03129109E3	03139109E3
	22	8 x 18	5	120	48	18	0.07	5.07	2.1	03129229E3	03139229E3
	33	10 x 18	6	200	70	24	0.07	3.38	1.4	03129339E3	03139339E3
	47	10 x 25	7	260	98	33	0.07	2.37	0.96	03129479E3	03139479E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minute at U_R:	
	Case Ø D x L = 3.3 x 11 and 4.5 x 10 mm	$I_{L1} \leq 0.05\ C_R \times U_R$ or 5 µA, whichever is greater
	Case Ø D x L = 6 x 10 to 10 x 25 mm	I_{L1} for CV ≤ 1000: $\leq 0.01\ C_R \times U_R$ or 1 µA, whichever is greater
		I_{L1} for CV > 1000: $\leq 0.006\ C_R \times U_R + 4$ µA
	U_R = 100 V	$I_{L1} = 0.02\ C_R \times U_R + 4$ µA
	After 5 minutes:	
	U_R = 6.3 to 63 V	$I_{L5} \leq 0.002\ C_R \times U_R + 5$ µA
	U_R = 100 V	$I_{L5} \leq 0.006\ C_R \times U_R + 4$ µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D x L mm:	
	3.3 x 11	typ. 11 nH
	4.5 x 10	typ. 10 nH
	6 x 10	typ. 22 nH
	8 x 11	typ. 85 nH
	6.5 x 18	typ. 25 nH
	8 x 18	typ. 40 nH
	10 x 18	typ. 61 nH
	10 x 25	typ. 38 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)

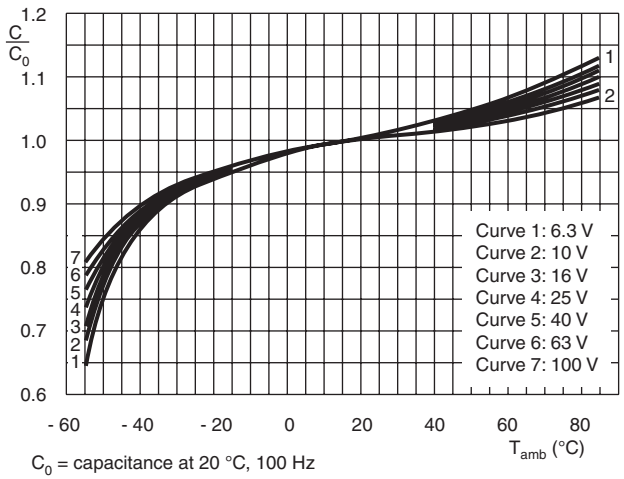


Fig.3 Typical multiplier of capacitance as a function of ambient temperature

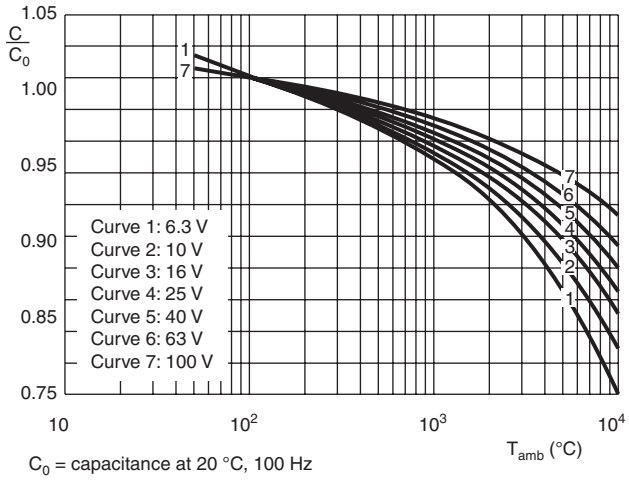


Fig.4 Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

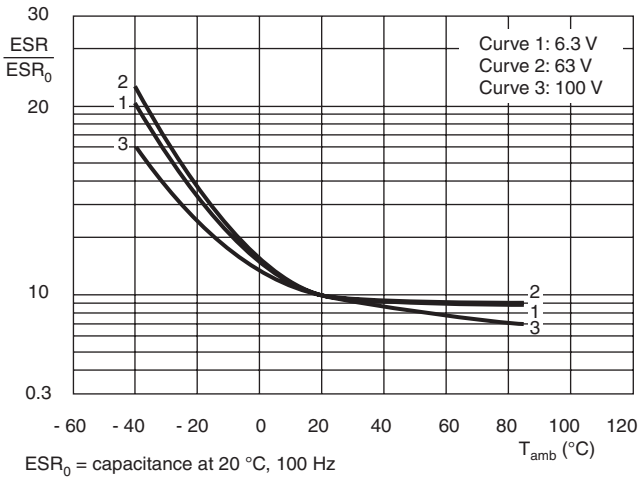


Fig.5 Typical multiplier of ESR as a function of ambient temperature

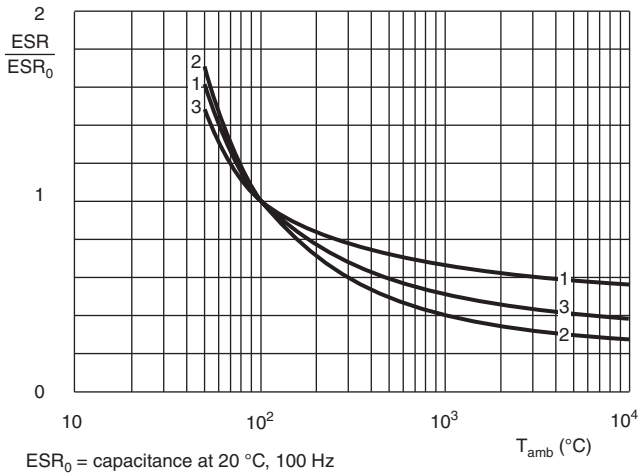


Fig.6 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

Table 3

IMPEDANCE VS. CAPACITANCE VALUES AT 10 kHz							
T_{amb}	$Z \times C_R$ (Ω x µF)						
	6.3 V	10 V	16 V	25 V	40 V	63 V	100 V
+ 20 °C	≤ 200	≤ 160	≤ 120	≤ 90	≤ 70	≤ 55	≤ 45
- 25 °C	≤ 1200	≤ 750	≤ 560	≤ 400	≤ 300	≤ 180	≤ 130
- 40 °C	≤ 3200	≤ 2000	≤ 1500	≤ 1100	≤ 900	≤ 500	≤ 350

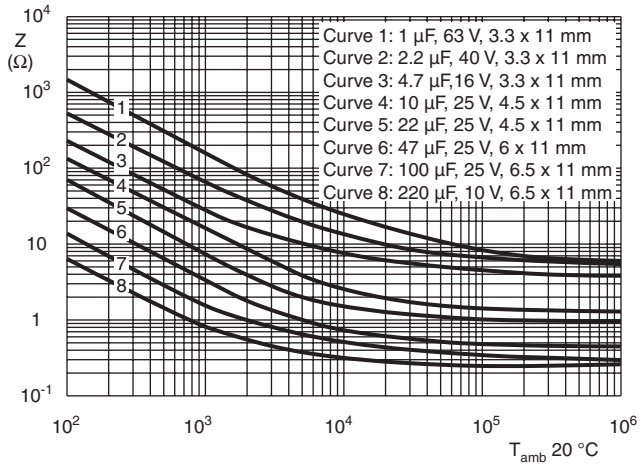


Fig.7 Typical impedance as a function of frequency

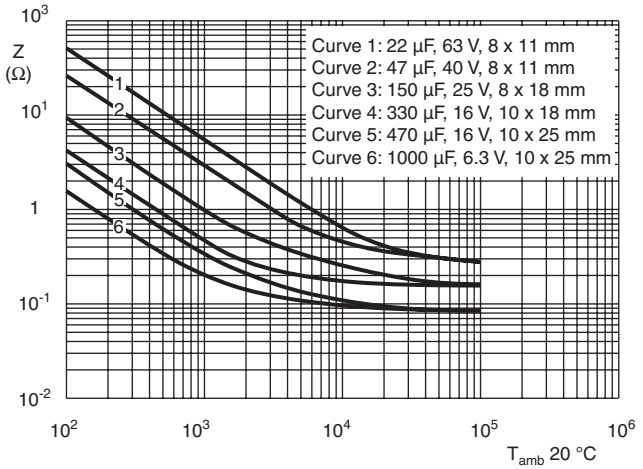
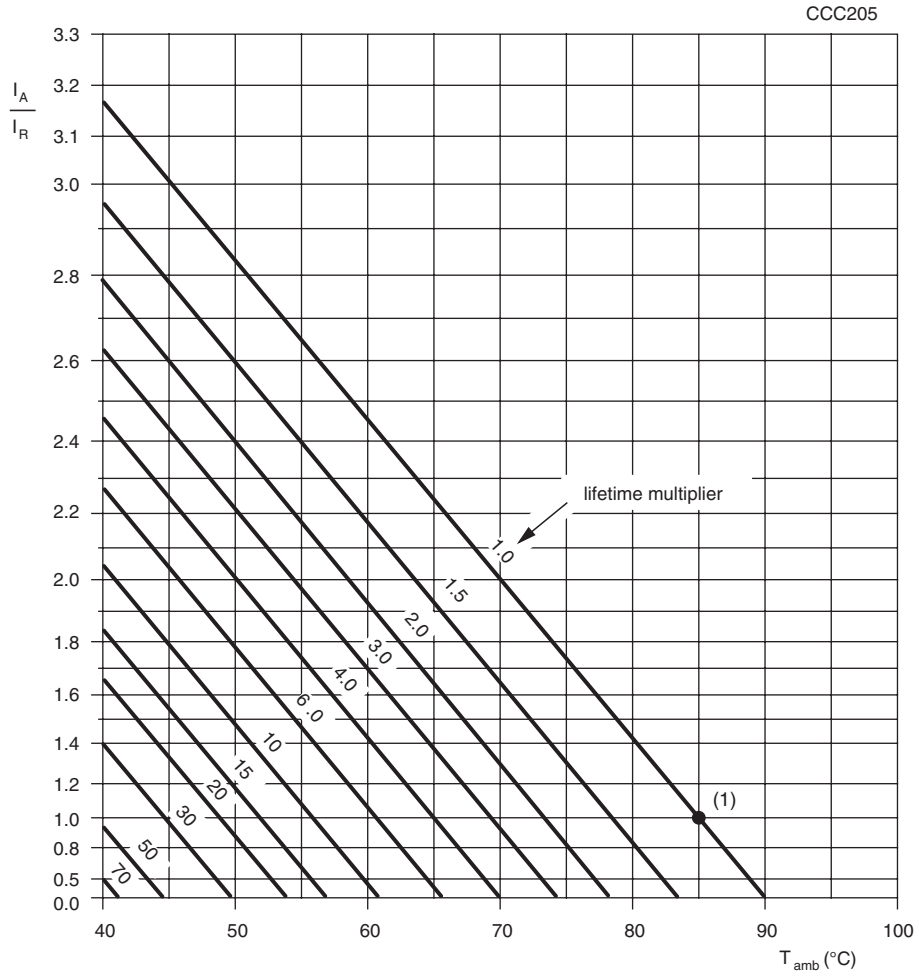


Fig.8 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 85 °C
(1) Useful life at 85 °C and IR applied:
case Ø D x L = 3.3 x 11 mm:1500 hours
case Ø D x L = 4.5 x 10 mm to 10 x 25 mm:
3000 hours

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (IR) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 25 V	U_R = 40 to 100 V
50	0.95	0.90	0.85
100	1.00	1.00	1.00
300	1.07	1.12	1.20
1000	1.12	1.20	1.30
3000	1.15	1.25	1.35
≥ 10 000	1.20	1.30	1.40

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Case Ø D x L = 3.3 x 11 mm			
Endurance	IEC 384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C ; U_R applied; 1000 hours	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit Z ≤ 3 x spec. limit I_L ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 1500 hours	ΔC/C: ± 50 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_L ≤ spec. limit no short or open circuit total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours After test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_L ≤ 2 x spec. limit
Case Ø D L = 4.5 x 10 to 10 x 25 mm			
Endurance	IEC 384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; 2000 hours	U_R ≤ 6.3 V; ΔC/C: + 15/- 30 % U_R > 6.3 V; ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_L ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 3000 hours	U_R ≤ 6.3 V; ΔC/C: + 45/- 50 % U_R > 6.3 V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_L ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours After test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_L ≤ 2 x spec. limit

Aluminum Capacitors
Axial Standard, High Voltage

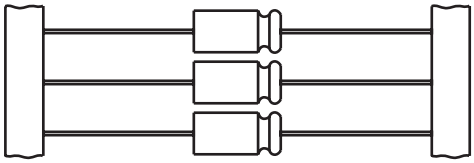
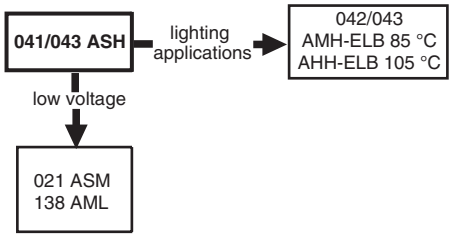


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Useful life: 5000 to 15 000 hours at 85 °C
- High rated voltage: up to 450 V
- Lead (Pb)-free versions are RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- General purpose, industrial, power supply, audio-video
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration and shock resistant

MARKING

The capacitors are marked (where possible) with the following information:

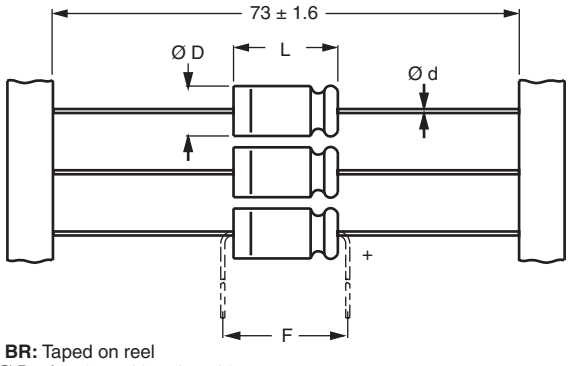
- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for - 10 to + 50 %)
- Rated voltage (in V)
- Upper category temperature (85 °C)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number (041, 042 or 043)

QUICK REFERENCE DATA		
DESCRIPTION	**VALUE**	
Nominal case sizes (Ø D x L in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	1 to 220 µF	
Tolerance on C_R	- 10 to + 50 %	
Rated voltage range, U_R	160 to 450 V	
Category temperature range	- 40 to + 85 °C (450 V: - 25 to + 85 °C)	
Endurance test at 85 °C	2000 hours	8000 hours (450 V: 5000 hours)
Useful life at 85 °C	5000 hours	15 000 hours (450 V: 10 000 hours)
Useful life at 40 °C	1.4 x I_R applied: 120 000 hours	1.8 x I_R applied: 240 000 hours (450 V: 160 000 hours)
Shelf life at 0 V, 85 °C	500 hours	500 hours
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/56 (450 V: 25/085/56)	

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

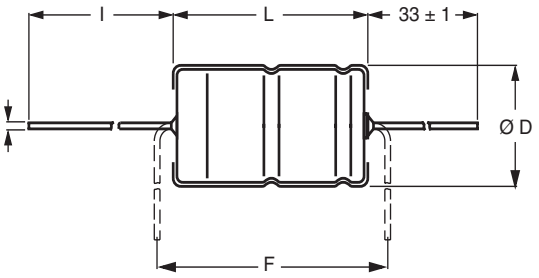
C_R (µF)	U_R (V)					
	160	**250**	**350**	**385**	**400**	**450**
1.0	-	-	-	6.5 x 18	-	-
2.2	-	6.5 x 18	-	8 x 18	-	-
4.7	6.5 x 18	8 x 18	10 x 18	10 x 25	-	-
6.8	-	-	10 x 30	10 x 30	10 x 30	10 x 30
10	8 x 18	10 x 25	12.5 x 30	12.5 x 30	12.5 x 30	12.5 x 30
	-	10 x 30	-	-	-	-
15	-	12.5 x 30	12.5 x 30	15 x 30	15 x 30	12.5 x 30
22	10 x 25	12.5 x 30	15 x 30	18 x 30	18 x 30	15 x 30
	10 x 30	-	-	-	-	-
33	12.5 x 30	15 x 30	18 x 30	18 x 38	18 x 38	18 x 30
47	15 x 30	18 x 30	18 x 38	18 x 38	18 x 38	18 x 38
68	15 x 30	18 x 38	21 x 38	21 x 38	21 x 38	21 x 38
100	18 x 30	21 x 38	-	-	-	-
150	18 x 38	-	-	-	-	-
220	21 x 38	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm
Form BA: Taped in box (ammopack)
case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.2 **Forms BA and BR**



Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

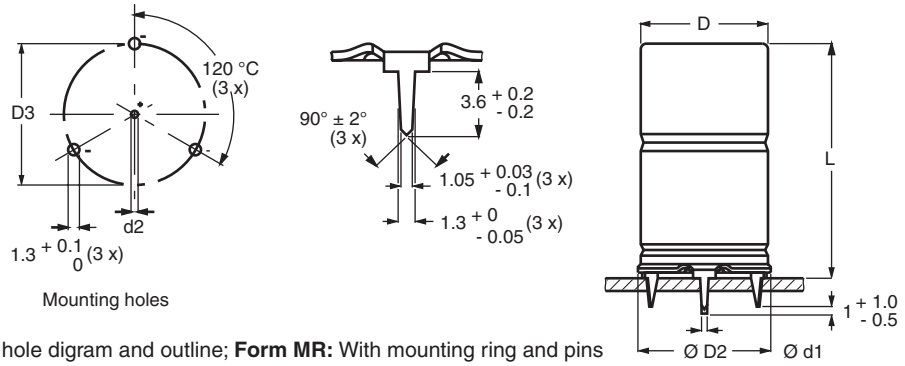
Fig.3 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES										
NOMINAL CASE SIZE Ø D X L	CASE CODE	AXIAL: FORM AA, BA, AND BR					MASS (g)	PACKAGING QUANTITIES		
		Ø d	l	Ø $D_{max.}$	$L_{max.}$	$F_{min.}$		FORM AA	FORM BA	FORM BR
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note
Detailed tape dimensions see section 'PACKAGING'.

Case Ø D x L = 15 x 30 to 21 x 38 mm
Case not insulated (insulation on request)
Especially for applications with severe shocks and vibrations



Mounting holes

Fig.4 Mounting hole digram and outline; **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
Nominal CASE SIZE Ø D x L	CASE code	MOUNTING RING: Form MR						MASS (g)	PACKAGING QUANTITIES
		Ø d1	Ø d2	Ø $D_{max.}$	Ø $D2_{max.}$	D3	$L_{max.}$		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 12.9	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 19.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 24.0	100

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance - 10 to + 50
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note
Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 041 series

10 µF/250 V; - 10/+ 50 %

Nominal case size: Ø 10 x 25 mm; Form BA

Ordering code: MAL204133109E3
Former 12NC: 2222 041 33109

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2..... IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
160	4.7	6.5 x 18	4	50	38	8	0.15	51	26	-	04121478E3	04131478E3	-
	10	8 x 18	5	70	68	14	0.15	24	12	-	04121109E3	04131109E3	-
	22	10 x 25	7	150	130	25	0.15	11	5.5	-	04121229E3	04131229E3	-
	22	10 x 30	00	190	42	25	0.10	6.8	5.5	04211229E3	04221229E3	-	-
	33	12.5 x 30	01	270	58	36	0.10	4.5	3.1	04211339E3	04221339E3	-	-
	47	15 x 30	02	350	78	49	0.10	3.2	2.1	04211479E3	04221479E3	-	04241479E3
	68	15 x 30	02	420	110	69	0.10	2.2	1.4	04211689E3	04221689E3	-	04241689E3
	100	18 x 30	03	580	150	100	0.10	1.5	1.0	04211101E3	-	-	04241101E3
	150	18 x 38	04	760	230	150	0.10	1.0	0.7	04311151E3	-	-	04341151E3
	220	21 x 38	05	940	330	220	0.10	0.7	0.5	04311221E3	-	-	04341221E3
250	2.2	6.5 x 18	4	35	28	6	0.10	72	50	-	04123228E3	04133228E3	-
	4.7	8 x 18	5	55	55	11	0.10	34	23	-	04123478E3	04133478E3	-
	10	10 x 25	7	90	95	19	0.10	16	11	-	04123109E3	04133109E3	-
	10	10 x 30	00	130	33	19	0.10	15	11	04213109E3	04223109E3	-	-
	15	12.5 x 30	01	180	44	27	0.10	10	7.4	04213159E3	04223159E3	-	-
	22	12.5 x 30	01	220	60	37	0.10	6.8	5.0	04213229E3	04223229E3	-	-
	33	15 x 30	02	290	84	54	0.10	4.5	3.4	04213339E3	04223339E3	-	04243339E3
	47	18 x 30	03	400	120	75	0.10	3.2	2.3	04213479E3	-	-	04243479E3
	68	18 x 38	04	520	160	110	0.10	2.2	1.7	04313689E3	-	-	04343689E3
	100	21 x 38	05	650	240	150	0.10	1.5	1.1	04313101E3	-	-	04343101E3
350	4.7	10 x 18	6	60	69	14	0.10	34	22	-	04125478E3	04135478E3	-
	6.8	10 x 30	00	110	32	18	0.10	22	14	04215688E3	04225688E3	-	-
	10	12.5 x 30	01	150	42	25	0.10	15	10	04215109E3	04225109E3	-	-
	15	12.5 x 30	01	180	57	36	0.10	10	6.7	04215159E3	04225159E3	-	-
	22	15 x 30	02	250	79	50	0.10	6.8	4.5	04215229E3	04225229E3	-	04245229E3
	33	18 x 30	03	350	110	73	0.10	4.5	3.1	04215339E3	-	-	04245339E3
	47	18 x 38	04	450	160	100	0.10	3.2	2.1	04315479E3	-	-	04345479E3
	68	21 x 38	05	560	220	150	0.10	2.2	1.4	04315689E3	-	-	04345689E3
385	1	6.5 x 18	4	20	19	4	0.10	160	100	-	04128108E3	04138108E3	-
	2.2	8 x 18	5	40	42	8	0.10	72	45	-	04128228E3	04138228E3	-
	4.7	10 x 25	7	70	71	15	0.10	34	22	-	04128478E3	04138478E3	-
	6.8	10 x 30	00	110	34	20	0.10	22	14	04218688E3	04228688E3	-	-
	10	12.5 x 30	01	150	45	27	0.10	15	10	04218109E3	04228109E3	-	-
	15	15 x 30	02	210	62	39	0.10	10	6.0	04218159E3	04228159E3	-	04248159E3
	22	18 x 30	03	290	86	55	0.10	6.8	4.1	04218229E3	-	-	04248229E3
	33	18 x 38	04	380	120	80	0.10	4.5	2.7	04318339E3	-	-	04348339E3
	47	18 x 38	04	450	170	110	0.10	3.2	2.1	04318479E3	-	-	04348479E3
	68	21 x 38	05	570	250	160	0.10	2.2	1.4	04318689E3	-	-	04348689E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2..... IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
400	6.8	10 x 30	00	110	220	110	0.055	11.5	7.3	04216688E3	04226688E3	-	-
	10	12.5 x 30	01	150	240	110	0.055	7.5	4.6	04216109E3	04226109E3	-	-
	15	15 x 30	02	210	250	110	0.055	5.0	3.1	04216159E3	04226159E3	-	04246159E3
	22	18 x 30	03	290	280	120	0.055	3.5	2.1	04216229E3	-	-	04246229E3
	33	18 x 38	04	380	320	130	0.055	2.3	1.4	04316339E3	-	-	04346339E3
	47	18 x 38	04	450	370	140	0.055	1.7	1.1	04316479E3	-	-	04346479E3
	68	21 x 38	05	560	440	150	0.055	1.2	0.7	04316689E3	-	-	04346689E3
450	6.8	10 x 30	00	110	230	110	0.10	22	14	04217688E3	04227688E3	-	-
	10	12.5 x 30	01	150	240	110	0.10	15	10	04217109E3	04227109E3	-	-
	15	12.5 x 30	01	180	260	110	0.10	10	6	04217159E3	04227159E3	-	-
	22	15 x 30	02	240	290	120	0.10	6.8	4.1	04217229E3	04227229E3	-	04247229E3
	33	18 x 30	03	350	330	130	0.10	4.5	2.7	04217339E3	-	-	04247339E3
	47	18 x 38	04	440	390	140	0.10	3.2	2.1	04317479E3	-	-	04347479E3
	68	21 x 38	05	550	460	160	0.10	2.2	1.4	04317689E3	-	-	04347689E3

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage	U_R = 160 to 250 V	$U_s \leq 1.15 \times U_R$	
	U_R = 350 to 450 V	$U_s \leq 1.1 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	After 1 minute:		
	case Ø		
	CV ≤ 1000 µC	$I_{L1} \leq 0.05\ C_R \times U_R$ or 5 µA, whichever is greater	
	CV > 1000 µC	$I_{L1} \leq 0.03\ C_R \times U_R + 20$ µA	
	case Ø D x L = 10 x 30 to 21 x 38 mm:		
	U_R = 160 to 385 V	$I_{L1} \leq 0.009\ C_R \times U_R + 10$ µA	
	U_R = 400 and 450 V	$I_{L1} \leq 0.009\ C_R \times U_R + 200$ µA	
	After 5 minutes:		
	U_R = 160 to 385 V:		
	CV ≤ 1000 µC	$I_{L5} \leq 0.01\ C_R \times U_R$ or 1 µA, whichever is greater	
	CV > 1000 µC	$I_{L5} \leq 0.006\ C_R \times U_R + 4$ µA	
	U_R = 400 and 450 V	$I_{L5} \leq 0.002\ C_R \times U_R + 100$ µA	
Inductance			
Equivalent series inductance (ESL)	case Ø D x L mm:		
	6.5 x 18	typ. 15 nH	-
	8 x 18	typ. 35 nH	-
	10 x 18	typ. 69 nH	-
	10 x 25	typ. 38 nH	-
	10 x 30	typ. 38 nH	-
	12.5 x 30	typ. 46 nH	-
	15 x 30	typ. 48 nH	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

CAPACITANCE (C)

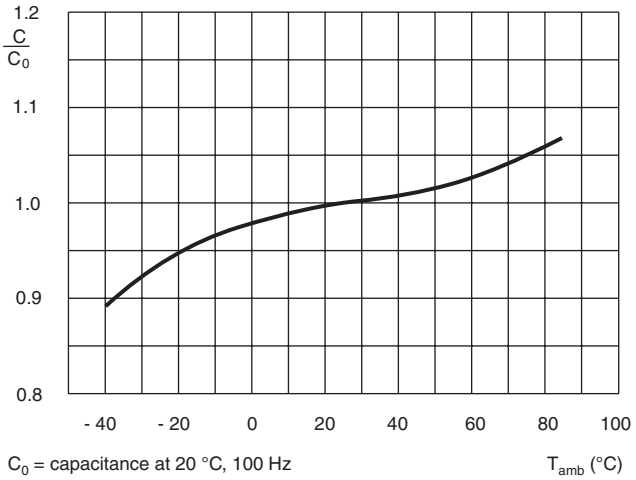


Fig.5 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

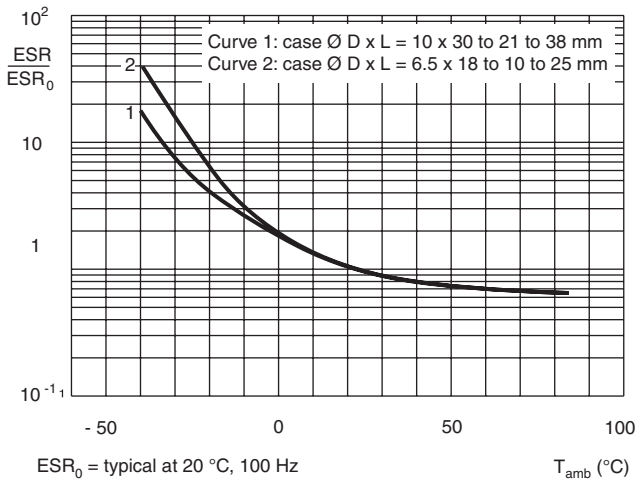


Fig.6 Typical multiplier of ESR as a function of ambient temperature

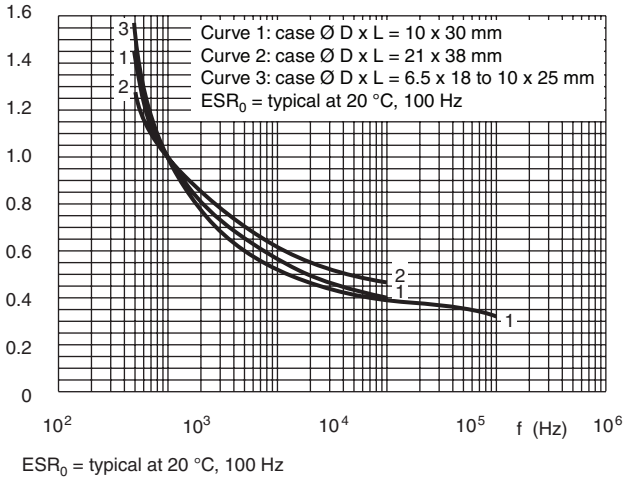


Fig.7 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

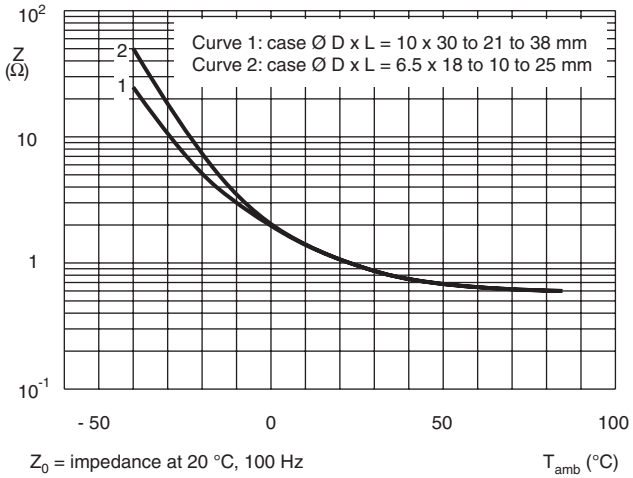


Fig.8 Typical impedance of capacitance as a function of ambient temperature

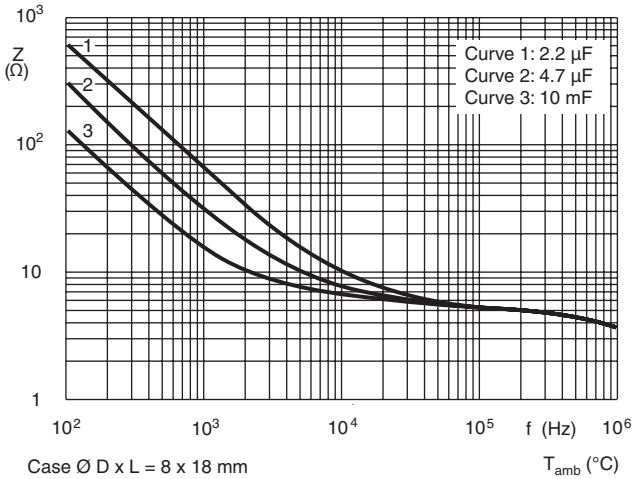


Fig.9 Typical impedance as a function of frequency

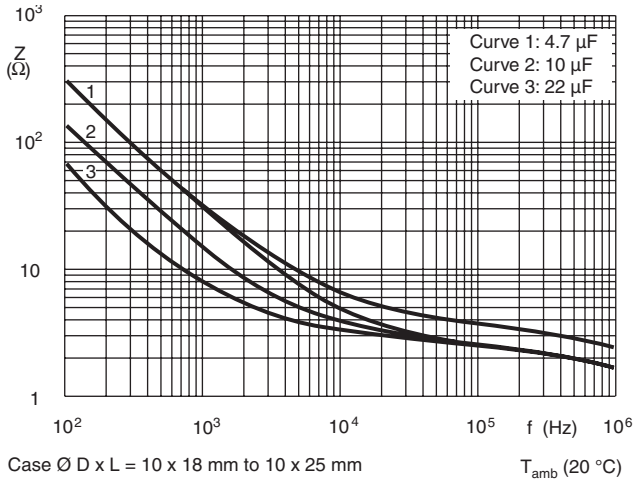


Fig.10 Typical impedance as a function of frequency

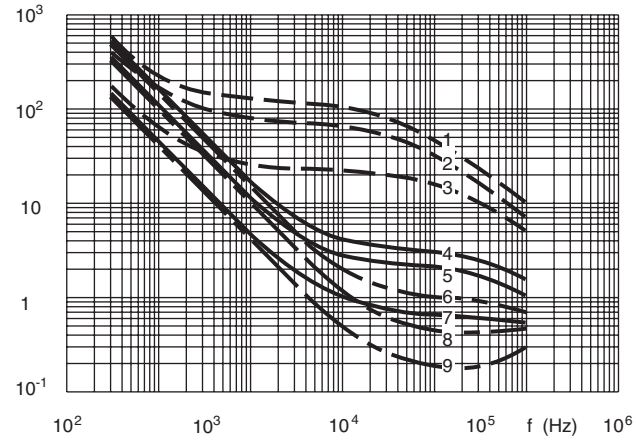
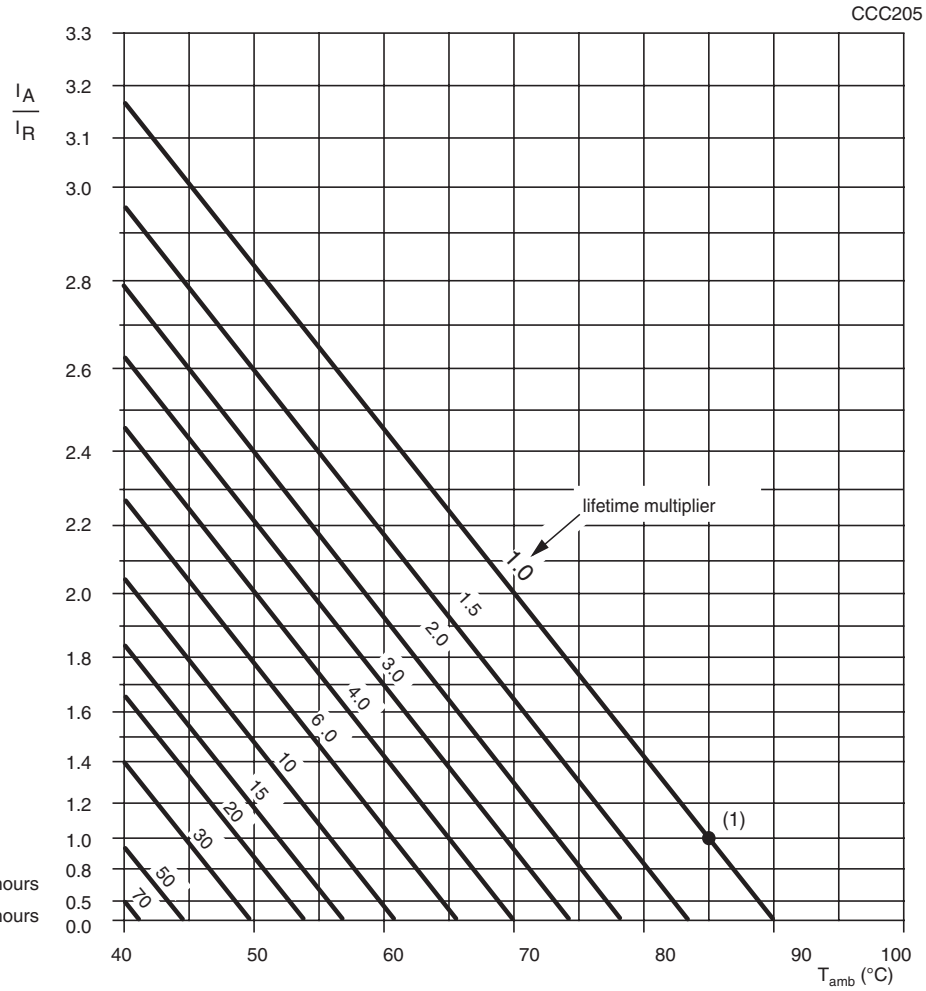


Fig.11 Typical impedance as a function of frequency at different ambient temperatures

Curve 1: 10 µF, 350 and 385 V; - 40 °C
Curve 2: 15 µF, 250 V; - 40 °C
Curve 3: 33 µF, 160 V; - 40 °C
Curve 4: 10 µF, 350 and 385 V; 20 °C
Curve 5: 15 µF, 250 V; 20 °C
Curve 6: 33 µF, 160 V; 20 °C
Curve 7: 10 µF, 350 and 385 V; 85 °C
Curve 8: 15 µF, 250 V; 85 °C
Curve 9: 33 µF, 160 V; 85 °C

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz

I_R = rated ripple at 100 Hz, 85 °C

(1) Useful life at 85 °C and IR applied;
case Ø D x L = 6.5 x 18 to 10 x 25 mm: 5000 hours
case Ø D x L = 6.5 x 18 to 10 x 25 mm: 5000 hours
(450 V: 10 000 hours)

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER**
50	0.75
100	1.00
300	1.15
1000	1.30
3000	1.40
≥ 10 000	1.50

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; case Ø D x L: 6.5 x 18 to 10 x 25 mm: 2000 hours; 10 x 30 to 21 x 38 mm 8000 hours (450 V: 5000 hours)	U_R = 160 V; $\Delta C/C$: ± 15 % U_R = 250 to 450 V; $\Delta C/C$: ± 10 % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; case Ø D x L: 6.5 x 18 to 10 x 25 mm: 5000 hours; 10 x 30 to 21 x 38 mm: 15 000 hours (450 V: 10 000 hours)	U_R = 160 V; $\Delta C/C$: ± 45 % U_R = 250 to 450 V; $\Delta C/C$: ± 30 % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq$ 2 x spec. limit

Aluminum Capacitors
Axial Miniature High Voltage for E.L.B.

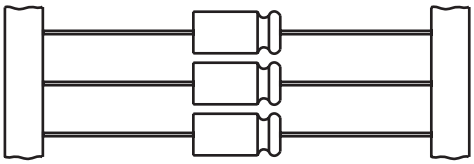


Fig.1 Component outlines

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Useful life: 20 000 hours
- Stable under overvoltage conditions: 550 V for 24 hours at 85 °C
- High ripple current capability
- Smallest dimensions
- Lead (Pb)-free versions are RoHS compliant

Pb-free Available

RoHS* COMPLIANT

APPLICATIONS

- Electronic lighting ballast, power supply
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration and shock resistant

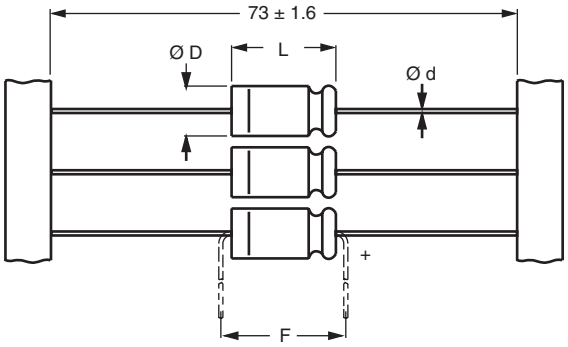
MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for - 10 to + 50 %)
- Rated voltage (in V)
- Upper category temperature (85 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number (042 or 043)

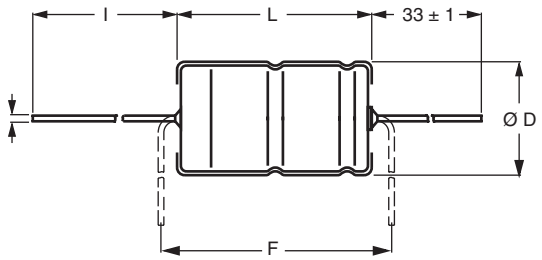
QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	12.5 x 30 to 18 x 38
Rated capacitance range, C_R	6.8 to 33 µF
Tolerance on C_R	- 10 to + 50 %
Rated voltage, U_R	450 V
Category temperature range	- 25 to + 85 °C
Endurance test at 85 °C	8000 hours
Useful life at 85 °C	20 000 hours
Useful life at 70 °C, I_R applied	100 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	25/085/56

DIMENSIONS in millimeters AND AVAILABLE FORMS



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm

Fig.2 **Form BR**



Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

Fig.3 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	AXIAL: FORM AA and BR					MASS (g)	PACKAGING QUANTITIES	
		Ø d	l	Ø $D_{max.}$	$L_{max.}$	$F_{min.}$		FORM AA	FORM BR
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 6.1	260	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 8.3	200	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 11.6	120	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 16.0	125	-

Note
Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance - 10/+ 50 %
I_R	rated RMS ripple current at 10 kHz, 85 °C
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	typ/max. equivalent series resistance at 100 Hz
Z	typ/max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in table 2 apply at T_{amb} = 20 °c, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 042 series

10 µF/450 V; - 10/+ 50 %

Nominal case size: Ø 12.5 x 30 mm; Form BR

Ordering code: MAL204282109E3
Former 12NC: 2222 042 82109

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION										
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 10 kHz 85 °C (mA)	I_{L5} 5 min (µA)	ESR TYP. 100 Hz (Ω)	ESR MAX. 100 Hz (Ω)	Z TYP. 10 kHz (Ω)	Z MAX. 10 kHz (Ω)	ORDERING CODE MAL2..... AXIAL	
									IN BOX FORM AA	TAPED ON REEL FORM BR
450	6.8	12.5 x 30	540	106	3.8	8.3	2.8	4.8	04281688E3	04282688E3
	10	12.5 x 30	710	110	2.6	5.6	1.8	3.1	04281109E3	04282109E3
	15	15 x 30	910	115	1.7	3.7	1.2	2.1	04281159E3	04282159E3
	22	18 x 30	1190	120	1.1	2.4	0.9	1.4	04281229E3	-
	33	18 x 38	1610	130	0.8	1.7	0.6	1.0	04381339E3	-

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	U_R = 450 V	$U_s \leq$ 550 V
Overvoltage test	24 hours at 85 °C	550 V (1)
Reverse voltage		$U_{rev} \leq$ 1 V
Current		
Leakage current	After 1 minute	$I_{L1} \leq 0.009 \times C_R \times U_R + 200$ µA
	After 5 minutes	$I_{L5} \leq 0.002 \times C_R \times U_R + 100$ µA
Inductance		
Equivalent series inductance	Case Ø D x L in mm:	
	12.5 x 30	typ. 46 nH
	15 x 30	typ. 48 nH
	18 x 30	typ. 50 nH
	18 x 38	typ. 54 nH

Note
(1) Test conditions on request.

CAPACITANCE (C)

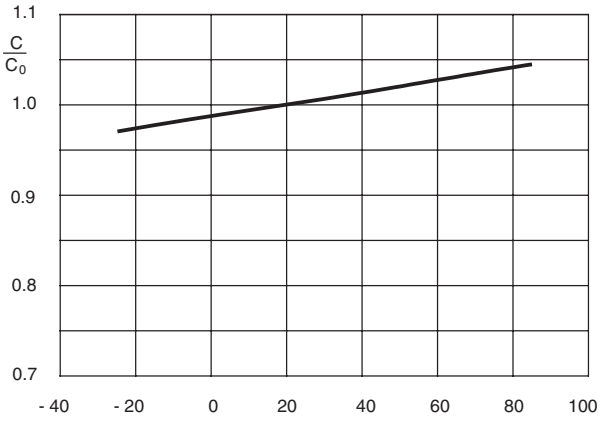


Fig.4 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

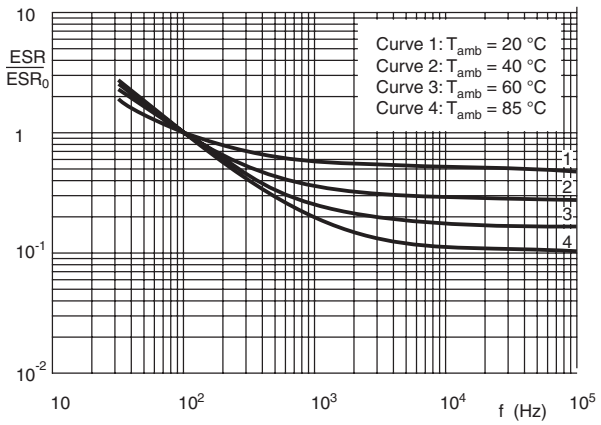


Fig.5 Typical multiplier of ESR as a function of frequency at different ambient temperatures

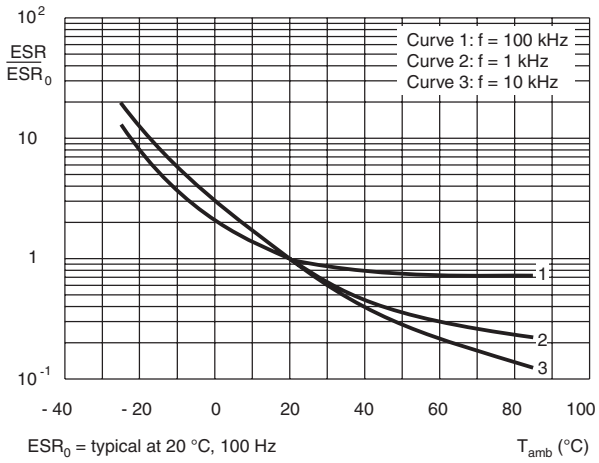


Fig.6 Typical multiplier of ESR as a function of ambient temperature at different frequencies

IMPEDANCE (Z)

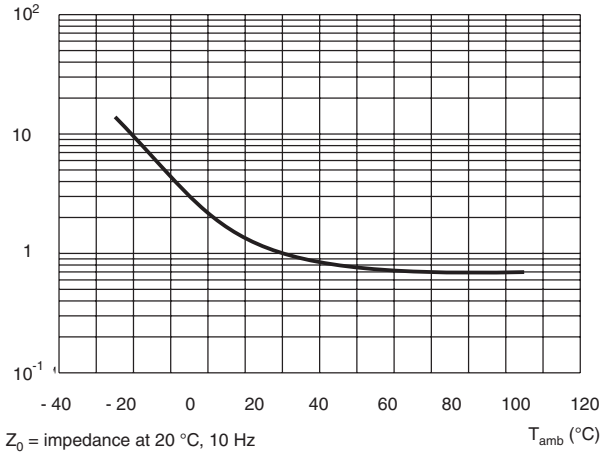


Fig.7 Typical multiplier of impedance as a function of ambient temperature

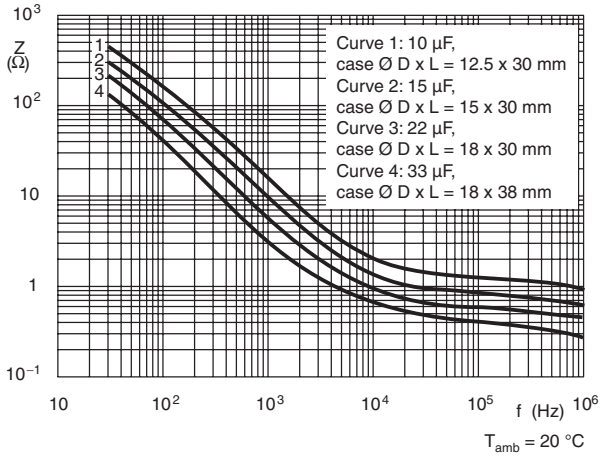
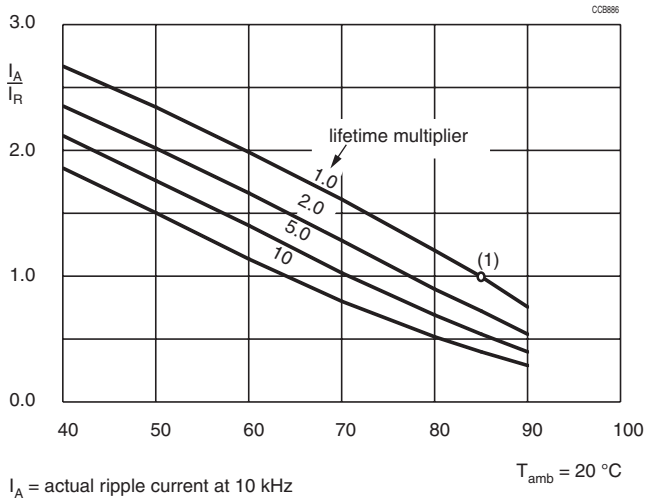


Fig.8 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 10 kHz

I_R = rated ripple current at 10 kHz, 85 °C

(1) Useful life at 85 °C and I_R applied: 20 000 hours

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER**
50	0.22
100	0.30
300	0.49
1000	0.72
3000	0.89
≥ 10 000	1.00

Note

Formula (1) should be used to calculate the actual ripple current at 10 kHz (see Fig. 9) when multiple frequencies are present. For an example of the values 100 Hz and 50 kHz:

$$I_A = \sqrt{\left(\frac{I(100\ Hz)}{0.30}\right)^2 + \left(\frac{I(50\ kHz)}{1.0}\right)^2} \quad (1)$$

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; 8000 hours	$\Delta C/C$: ± 10 % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 20 000 hours	$\Delta C/C$: ± 30 % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq$ 2 x spec. limit

Aluminum Capacitors
Axial High Temperature High Voltage for E.L.B.

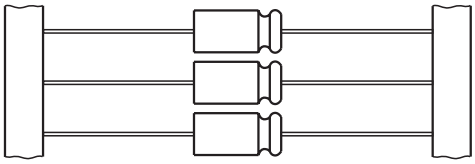


Fig.1 Component outlines

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	12.5 x 30 to 18 x 38
Rated capacitance range, C_R	6.8 to 33 µF
Tolerance on C_R	- 10 to + 50 %
Rated voltage, U_R	450 V
Category temperature range	- 25 to + 105 °C
Endurance test at 105 °C	5000 hours
Useful life at 105 °C	10 000 hours
Useful life at 85 °C I_R applied	100 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	25/105/56

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Useful life: 10 000 hours at 105 °C
- Stable under overvoltage conditions: 550 V for 24 hours at 85 °C
- High ripple current capability
- Smallest dimensions
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

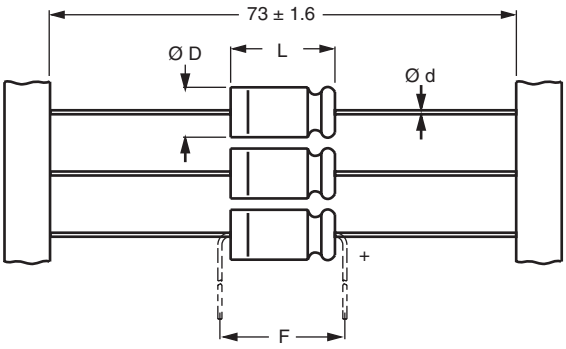
- Electronic lighting ballast, power supply
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration and shock resistant

MARKING

The capacitors are marked (where possible) with the following information:

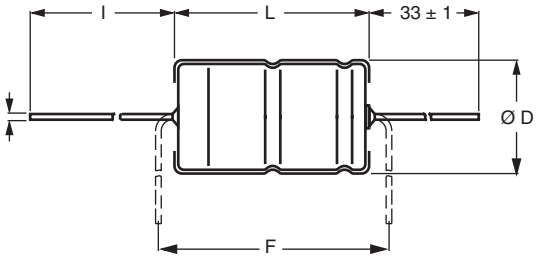
- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for - 10 to + 50 %)
- Rated voltage (in V)
- Upper category temperature (105 °C)
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series Number (042 or 043)

DIMENSIONS in millimeters AND AVAILABLE FORMS



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm

Fig.2 **Form BR**



Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

Fig.3 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE Ø D x L	CASE CODE	AXIAL: FORM AA AND BR					MASS (G)	PACKAGING QUANTITIES	
		Ø D	L	Ø $D_{max.}$	$L_{max.}$	$F_{min.}$		FORM AA	FORM BR
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 6.1	260	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 8.3	200	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 11.6	120	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 16.0	125	-

Note
1. Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance - 10/+ 50 %
I_R	rated RMS ripple current at 10 kHz, 105 °C
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	typ/max. equivalent series resistance at 100 Hz
Z	typ/max. impedance at 10 kHz

Note
Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 042 series

10 µF/450 V; - 10/+ 50 %

Nominal case size: Ø 12.5 x 30 mm; Form BR

Ordering code: MAL204272109E3
Former 12NC: 2222 042 72109

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION										
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 10 kHz 105 °C (mA)	I_{L5} 5 min (µA)	ESR TYP. 100 Hz (Ω)	ESR MAX. 100 Hz (Ω)	Z TYP. 10 kHz (Ω)	Z MAX. 10 kHz (Ω)	ORDERING CODE MAL2..... AXIAL	
									IN BOX FORM AA	TAPED ON REEL FORM BR
450	6.8	12.5 x 30	390	106	4.2	8.7	3.1	5.1	04271688E3	04272688E3
	10	12.5 x 30	470	110	2.9	5.9	2.0	3.3	04271109E3	04272109E3
	15	15 x 30	600	115	1.9	3.9	1.3	2.3	04271159E3	04272159E3
	22	18 x 30	750	120	1.2	2.5	1.0	1.5	04271229E3	-
	33	18 x 38	1020	130	0.9	1.8	0.7	1.1	04371339E3	-

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	U_R = 450 V	$U_s \leq$ 550 V
Overvoltage test	24 hours at 85 °C	550 V (1)
Reverse voltage		$U_{rev} \leq$ 1 V
Current		
Leakage current	After 1 minute	$I_{L1} \leq 0.009 \times C_R \times U_R + 200$ µA
	After 5 minutes	$I_{L5} \leq 0.002 \times C_R \times U_R + 100$ µA
Inductance		
Equivalent series inductance	Case Ø D x L in mm:	
	12.5 x 30	typ. 46 nH
	15 x 30	typ. 48 nH
	18 x 30	typ. 50 nH
	18 x 38	typ. 54 nH

Note
(1) Test conditions on request.

CAPACITANCE (C)

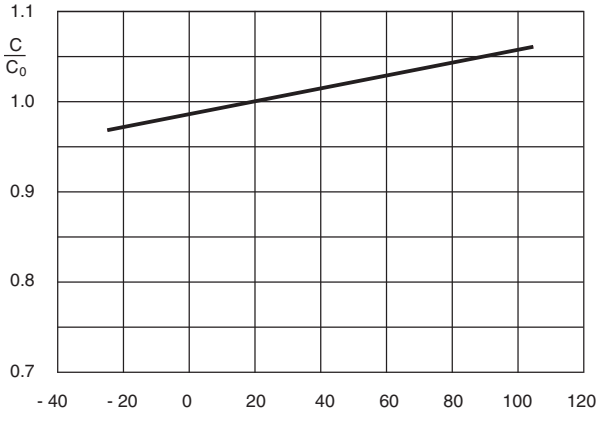


Fig.4 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

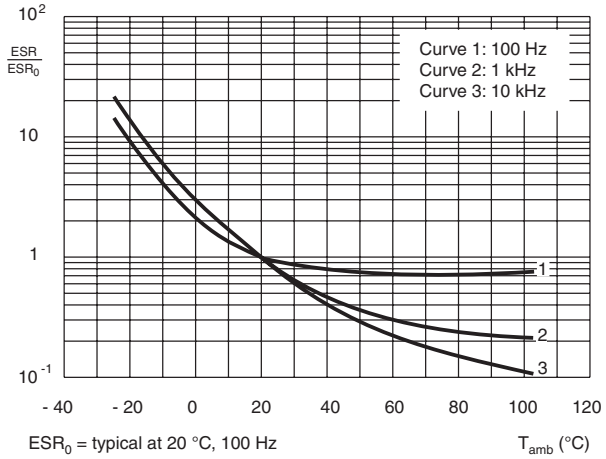


Fig.5 Typical multiplier of ESR as a function of ambient temperature at different frequencies

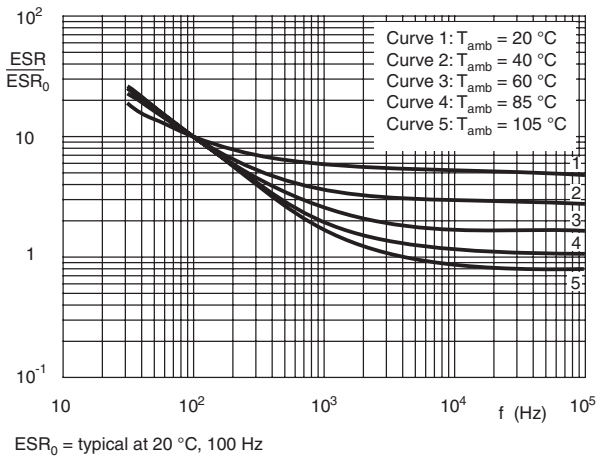


Fig.6 Typical multiplier of ESR as a function of frequency at different ambient temperatures

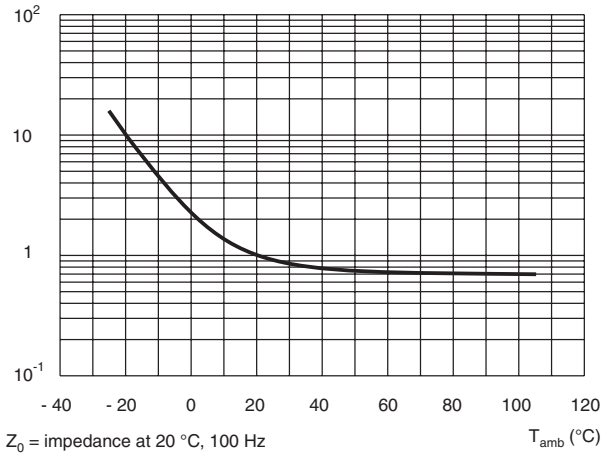


Fig.7 Typical multiplier of impedance as a function of ambient temperature

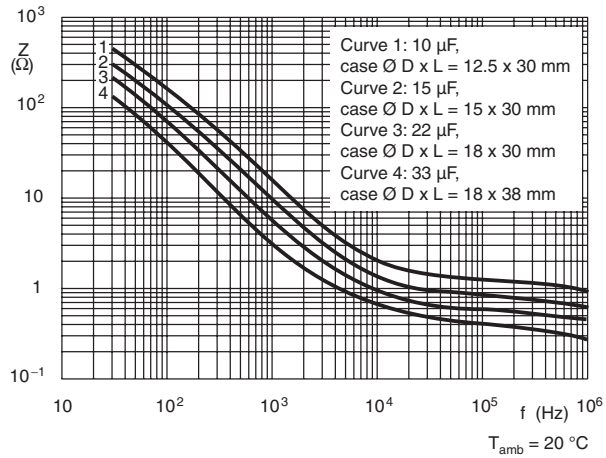
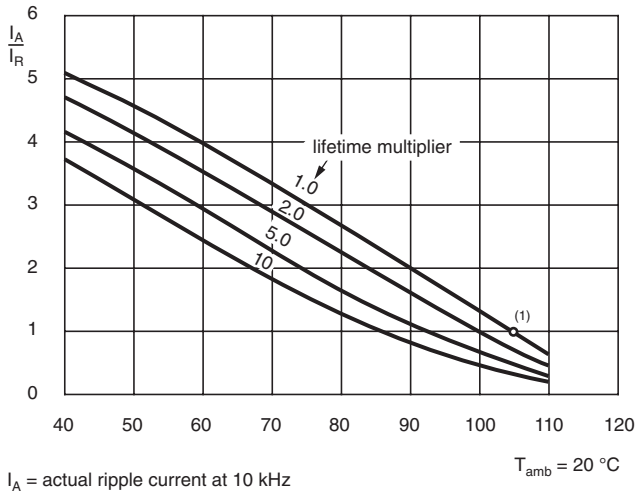


Fig.8 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 10 kHz

I_R = rated ripple current at 10 kHz, 105 °C

(1) Useful life at 105 °C and IR applied: 10 000 hours

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER**
50	0.20
100	0.27
300	0.45
1000	0.68
3000	0.82
≥ 10 000	1.00

Note

Formula (1) should be used to calculate the actual ripple current at 10 kHz (see Fig.9) when multiple frequencies are present. For an example of the values 100 Hz and 50 kHz:

$$I_A = \sqrt{\left(\frac{I(100Hz)}{0.27}\right)^2 + \left(\frac{I(50kHz)}{1.0}\right)^2} \quad (1)$$

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; 5000 hours	$\Delta C/C$: ± 10 % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 10 000 hours	$\Delta C/C$: ± 30 % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq$ 2 x spec. limit

Aluminum Capacitors
Axial Miniature, Long-Life

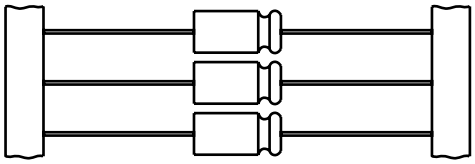


Fig.1 Component outlines

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
  (case Ø 6.3 x 12.7 and 7.7 x 12.7 mm are moulded with flame retardant plastic material)
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 2000 to 10 000 hours at 105 °C, high reliability
- High ripple current capability
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant

APPLICATIONS

- Industrial, automotive, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling, timing
- Portable and mobile equipment (small size, low mass)
- Stand-by applications
- Low mounting height boards, vibration and shock resistant

MARKING

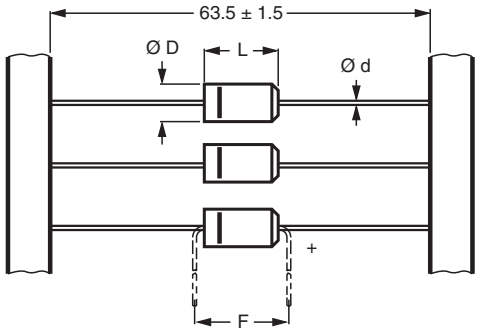
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (105 °C)
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal (not for case sizes L < 18 mm)
- Series number (138)

QUICK REFERENCE DATA		
DESCRIPTION	**VALUE**	
Nominal case sizes (Ø D x L in mm)	6.3 x 12.7 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	1.0 to 15 000 µF	
Tolerance on C_R	± 20 %	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	- 40 to + 105 °C	
Endurance test at 105 °C	1000 hours	5000 hours
Useful life at 105 °C	2000 hours	10 000 hours
Useful life at 40 °C, I_R applied	1.3 x I_R applied: 200 000 hours	1.8 x I_R applied: 500 000 hours
Shelf life at 0 V, 105 °C	500 hours	500 hours
Based on sectional specification	IEC 60384-4/EN130 300	
Climatic category IEC 60068	40/105/56	

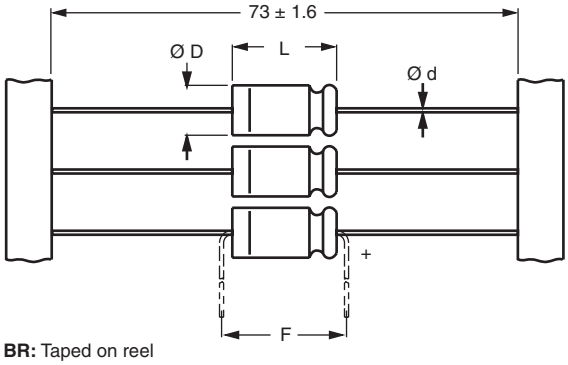
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)								
C_R (µF)	U_R (V)							
	6.3	10	16	25	40	50	63	100
1.0	-	-	-	-	-	-	-	6.3 x 12.7
2.2	-	-	-	-	-	-	-	6.3 x 12.7
4.7	-	-	-	-	-	-	6.3 x 12.7	7.7 x 12.7
10	-	-	-	6.3 x 12.7	-	6.3 x 12.7	7.7 x 12.7	6.5 x 18
22	-	-	6.3 x 12.7	6.3 x 12.7	-	7.7 x 12.7	6.5 x 18	8 x 18
33	-	-	-	6.3 x 12.7	7.7 x 12.7	-	-	-
47	-	-	6.3 x 12.7	7.7 x 12.7	6.5 x 18	-	8 x 18	10 x 25
68	-	-	-	-	-	-	-	10 x 30
100	6.3 x 12.7	-	7.7 x 12.7	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30
150	-	7.7 x 12.7	-	-	-	-	10 x 30	15 x 30
220	7.7 x 12.7	6.5 x 18	8 x 18	10 x 18	10 x 25	-	12.5 x 30	15 x 30
330	-	-	-	-	10 x 30	-	12.5 x 30	18 x 30
470	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30	-	15 x 30	18 x 38
680	-	-	-	10 x 30	12.5 x 30	-	18 x 30	21 x 38
1000	10 x 18	10 x 25	10 x 30	12.5 x 30	15 x 30	-	18 x 38	-
1500	-	10 x 30	12.5 x 30	15 x 30	18 x 30	-	21 x 38	-
2200	10 x 25	12.5 x 30	15 x 30	18 x 30	18 x 38	-	-	-
3300	-	15 x 30	18 x 30	18 x 38	21 x 38	-	-	-
4700	-	18 x 30	18 x 30	18 x 38	-	-	-	-
6800	-	18 x 38	18 x 38	21 x 38	-	-	-	-
10 000	-	18 x 38	21 x 38	-	-	-	-	-
15 000	-	21 x 38	-	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS



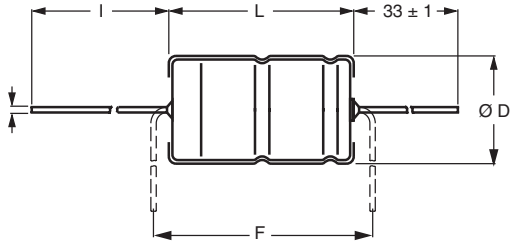
Form BR: Taped on reel
Form BA: Taped in box (ammopack)
case Ø D x L = 6.3 x 12.7 to 7.7 x 12.7 mm

Fig.2 **Forms BA and BR**



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm
Form BA: Taped in box (ammopack)
case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.3 **Forms BA and BR**



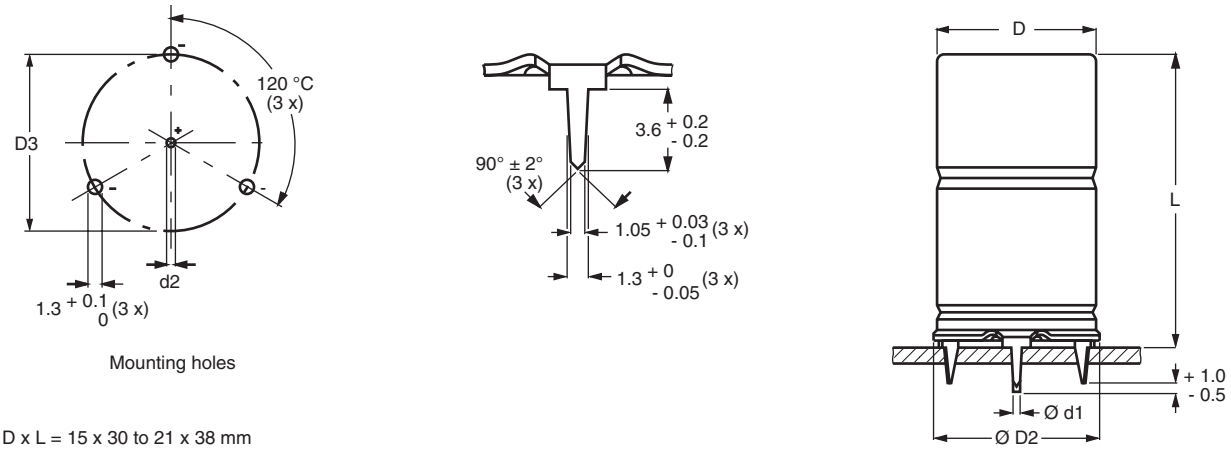
Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

Fig.4 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**										
NOMINAL CASE SIZE Ø D x L (mm)	**CASE CODE**	**AXIAL: FORM AA, BA, and BR**					**MASS (g)**	**PACKAGING QUANTITIES**		
		Ø d	**l**	**Ø $D_{max.}$**	**$L_{max.}$**	**$F_{min.}$**		**FORM AA**	**FORM BA**	**FORM BR**
6.3 x 12.7	(2)	0.6	-	6.5	12.9	17.5	≈ 1.1	-	1000	1000
7.7 x 12.7	(3)	0.6	-	7.9	12.9	17.5	≈ 1.3	-	500	500
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ±1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ±1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ±1	21.5	39.5	44	≈ 24.0	100	-	-

Note
Detailed tape dimensions see section 'PACKAGING'.



Case Ø D x L = 15 x 30 to 21 x 38 mm
Case not insulated (insulation on request)
Especially for applications with severe shocks and vibrations

Fig.5 Mounting hole digram and outline; **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**MOUNTING RING: FORM MR**						**MASS (g)**	**PACKAGING QUANTITIES**
		Ø d1	**Ø d2**	**$D_{max.}$**	**Ø $D2_{max.}$**	**D3**	**$L_{max.}$**		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 12.9	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 19.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 24.0	100

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 105 °C
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz or 100 kHz

Note

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 138 series

470 µF/10 V; ± 20 %

Nominal case size: Ø 8 x 18 mm; Form BA

Ordering code: MAL213834471E3
Former 12 NC: 2222 138 34471

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION

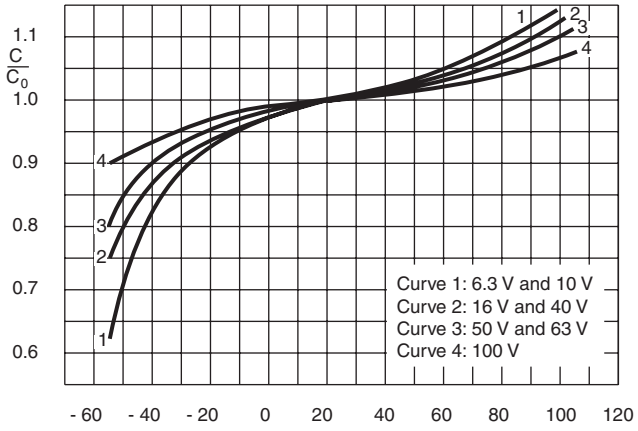
U_R (V)	C_R 100 HZ (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2138..... IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
6.3	100	6.3 x 12.7	99	5.3	0.24	3.8	3.0	1.8	-	23101E3	33101E3	-
	220	7.7 x 12.7	160	6.8	0.24	1.7	1.4	0.95	-	23221E3	33221E3	-
	470	6.5 x 18	250	9.9	0.24	0.81	0.64	0.5	-	23471E3	33471E3	-
	1000	10 x 18	430	17	0.24	0.38	0.30	0.24	-	23102E3	33102E3	-
	2200	10 x 25	640	32	0.29	0.21	0.18	0.15	-	23222E3	33222E3	-
10	150	7.7 x 12.7	140	7.0	0.2	2.1	1.3	0.95	-	24151E3	34151E3	-
	220	6.5 x 18	190	8.4	0.2	1.4	0.91	0.5	-	24221E3	34221E3	-
	470	8 x 18	300	13	0.2	0.68	0.43	0.35	-	24471E3	34471E3	-
	1000	10 x 25	520	24	0.2	0.32	0.20	0.16	-	24102E3	34102E3	-
	1500	10 x 30	670	34	0.28	0.32	0.26	0.26	14152E3	24152E3	-	-
	2200	12.5 x 30	890	48	0.29	0.22	0.19	0.19	14222E3	24222E3	-	-
	3300	15 x 30	1140	70	0.30	0.16	0.13	0.15	14332E3	24332E3	-	44332E3
	4700	18 x 30	1450	98	0.33	0.12	0.11	0.13	14472E3	-	-	44472E3
	6800	18 x 38	1880	140	0.34	0.085	0.074	0.11	14682E3	-	-	44682E3
	10 000	18 x 38	1980	200	0.41	0.070	0.062	0.10	14103E3	-	-	44103E3
	15 000	21 x 38	2200	300	0.55	0.063	0.058	0.099	14153E3	-	-	44153E3
16	22	6.3 x 12.7	58	4.7	0.12	8.7	7.3	2.7	-	25229E3	35229E3	-
	47	6.3 x 12.7	83	5.5	0.16	5.4	3.4	1.9	-	25479E3	35479E3	-
	100	7.7 x 12.7	130	7.2	0.16	2.5	1.6	1.0	-	25101E3	35101E3	-
	220	8 x 18	230	11	0.16	1.2	0.73	0.35	-	25221E3	35221E3	-
	470	10 x 18	360	19	0.16	0.54	0.34	0.25	-	25471E3	35471E3	-
	1000	10 x 30	630	36	0.20	0.34	0.27	0.26	15102E3	25102E3	-	-
	1500	12.5 x 30	860	52	0.20	0.23	0.19	0.19	15152E3	25152E3	-	-
	2200	15 x 30	1090	74	0.21	0.17	0.14	0.15	15222E3	25222E3	-	45222E3
	3300	18 x 30	1420	110	0.24	0.12	0.10	0.13	15332E3	-	-	45332E3
	4700	18 x 30	1480	150	0.28	0.10	0.090	0.12	15472E3	-	-	45472E3
	6800	18 x 38	1930	220	0.28	0.072	0.062	0.10	15682E3	-	-	45682E3
	10 000	21 x 38	2100	320	0.38	0.065	0.057	0.098	15103E3	-	-	45103E3
25	10	6.3 x 12.7	46	4.5	0.09	14	12	2.8	-	26109E3	36109E3	-
	22	6.3 x 12.7	61	5.1	0.14	10	5.5	2.5	-	26229E3	36229E3	-
	33	6.3 x 12.7	74	5.7	0.14	6.8	3.6	1.9	-	26339E3	36339E3	-
	47	7.7 x 12.7	96	6.4	0.14	4.7	2.6	1.0	-	26479E3	36479E3	-

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 HZ (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2138.....			
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
25	100	6.5 x 18	160	9.0	0.13	2.1	1.2	0.55	-	26101E3	36101E3	-
	220	10 x 18	270	15	0.13	0.94	0.55	0.27	-	26221E3	36221E3	-
	470	10 x 25	440	28	0.13	0.44	0.26	0.17	-	26471E3	36471E3	-
	680	10 x 30	580	38	0.14	0.36	0.26	0.25	16681E3	26681E3	-	-
	1000	12.5 x 30	790	54	0.15	0.25	0.18	0.19	16102E3	26102E3	-	-
	1500	15 x 30	1020	79	0.15	0.17	0.13	0.15	16152E3	26152E3	-	46152E3
	2200	18 x 30	1320	110	0.17	0.13	0.10	0.13	16222E3	-	-	46222E3
	3300	18 x 38	1720	170	0.17	0.090	0.071	0.11	16332E3	-	-	46332E3
	4700	18 x 38	1840	240	0.21	0.076	0.063	0.10	16472E3	-	-	46472E3
	6800	21 x 38	2100	340	0.27	0.068	0.058	0.099	16682E3	-	-	46682E3
40	33	7.7 x 12.7	91	6.6	0.11	5.3	2.7	1.0	-	27339E3	37339E3	-
	47	6.5 x 18	120	7.8	0.10	3.4	1.9	0.65	-	27479E3	37479E3	-
	100	8 x 18	180	12	0.10	1.6	0.9	0.40	-	27101E3	37101E3	-
	220	10 x 25	350	22	0.10	0.72	0.41	0.20	-	27221E3	37221E3	-
	330	10 x 30	490	30	0.09	0.47	0.32	0.30	17331E3	27331E3	-	-
	470	12.5 x 30	650	42	0.09	0.34	0.23	0.22	17471E3	27471E3	-	-
	680	12.5 x 30	750	58	0.10	0.25	0.18	0.18	17681E3	27681E3	-	-
	1000	15 x 30	970	84	0.10	0.17	0.12	0.14	17102E3	27102E3	-	47102E3
	1500	18 x 30	1250	120	0.12	0.13	0.098	0.12	17152E3	-	-	47152E3
	2200	18 x 38	1640	180	0.12	0.093	0.069	0.10	17222E3	-	-	47222E3
	3300	21 x 38	1810	270	0.15	0.079	0.061	0.10	17332E3	-	-	47332E3
50	10	6.3 x 12.7	51	5.0	0.09	14	7	2.7	-	21109E3	31109E3	-
	22	7.7 x 12.7	82	6.2	0.09	6.5	3.2	1.1	-	21229E3	31229E3	-
	100	10 x 18	230	14	0.08	1.3	0.7	0.30	-	21101E3	31101E3	-
63	4.7	6.3 x 12.7	35	4.6	0.09	30	17	5	-	28478E3	38478E3	-
	10	7.7 x 12.7	59	5.3	0.08	13	8	1.8	-	28109E3	38109E3	-
	22	6.5 x 18	100	6.8	0.07	5.1	3.6	0.85	-	28229E3	38229E3	-
	47	8 x 18	150	9.9	0.07	2.4	1.7	0.50	-	28479E3	38479E3	-
	100	10 x 25	280	17	0.07	1.1	0.8	0.27	-	28101E3	38101E3	-
	150	10 x 30	410	23	0.11	0.73	0.44	0.40	18151E3	28151E3	-	-
	220	12.5 x 30	560	32	0.11	0.50	0.31	0.29	18221E3	28221E3	-	-
	330	12.5 x 30	660	46	0.12	0.37	0.23	0.22	18331E3	28331E3	-	-
	470	15 x 30	860	63	0.12	0.26	0.16	0.16	18471E3	28471E3	-	48471E3
	680	18 x 30	1130	90	0.12	0.19	0.12	0.14	18681E3	-	-	48681E3
	1000	18 x 38	1460	130	0.12	0.13	0.086	0.11	18102E3	-	-	48102E3
	1500	21 x 38	1680	190	0.13	0.10	0.072	0.11	18152E3	-	-	48152E3
100	1.0	6.3 x 12.7	16	4.2	0.09	140	55	10	-	29108E3	39108E3	-
	2.2	6.3 x 12.7	24	4.4	0.09	65	25	8	-	29228E3	39228E3	-
	4.7	7.7 x 12.7	40	4.9	0.08	27	17	5	-	29478E3	39478E3	-
	10	6.5 x 18	67	6.0	0.07	11	8	2.4	-	29109E3	39109E3	-
	22	8 x 18	100	8.4	0.07	5.1	3.6	1.4	-	29229E3	39229E3	-
	47	10 x 25	190	13	0.07	2.4	1.7	0.67	-	29479E3	39479E3	-
	68	10 x 30	300	18	0.07	1.7	1.1	0.97	19689E3	29689E3	-	-
	100	12.5 x 30	410	24	0.07	1.1	0.77	0.67	19101E3	29101E3	-	-
	150	15 x 30	550	34	0.07	0.78	0.52	0.46	19151E3	29151E3	-	49151E3
	220	15 x 30	650	48	0.07	0.54	0.37	0.33	19221E3	29221E3	-	49221E3
	330	18 x 30	880	70	0.08	0.38	0.27	0.24	19331E3	-	-	49331E3
	470	18 x 38	1130	98	0.08	0.27	0.19	0.17	19471E3	-	-	49471E3
	680	21 x 38	1330	140	0.09	0.21	0.14	0.14	19681E3	-	-	49681E3

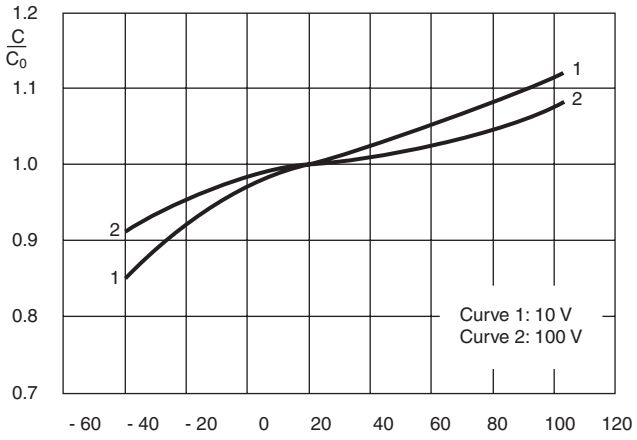
ADDITIONAL ELECTRICAL DATA			
PARAMETER	**CONDITIONS**	**VALUE**	
		AXIAL	**MOUNTING RING**
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1\ V$	
Current			
Leakage current	After 1 minute at U_R:		
	case Ø D x L = 6.3 x 12.7 and 7.7 x 12.7 mm	$I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$	
	case Ø D x L = 6.5 x 18 to 21 x 38 mm	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$	
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$	
Inductance			
Equivalent series inductance (ESL)	Case Ø D x L mm:		
	6.3 x 12.7	typ. 20 nH	-
	7.7 x 12.7	typ. 30 nH	-
	6.5 x 18	typ. 15 nH	-
	8 x 18	typ. 35 nH	-
	10 x 18	typ. 69 nH	-
	10 x 25	typ. 38 nH	-
	10 x 30	typ. 38 nH	-
	12.5 x 30	typ. 46 nH	-
	15 x 30	typ. 48 nH	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

CAPACITANCE (C)



Case Ø D x L = 6.3 x 12.7 to 10 x 25 mm
C_0 = typical at 20 °C, 100 Hz

Fig.6 Typical multiplier of capacitance as a function of ambient temperature



Case Ø D x L = 10 x 30 to 21 x 38 mm
C_0 = typical at 20 °C, 100 Hz

Fig.7 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

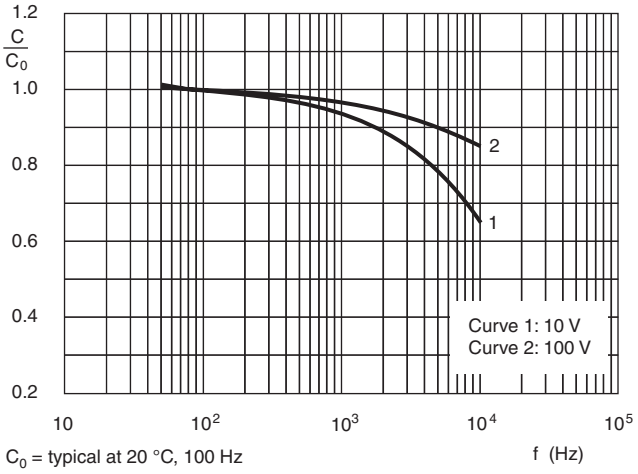


Fig.8 Typical multiplier of capacitance as a function of frequency

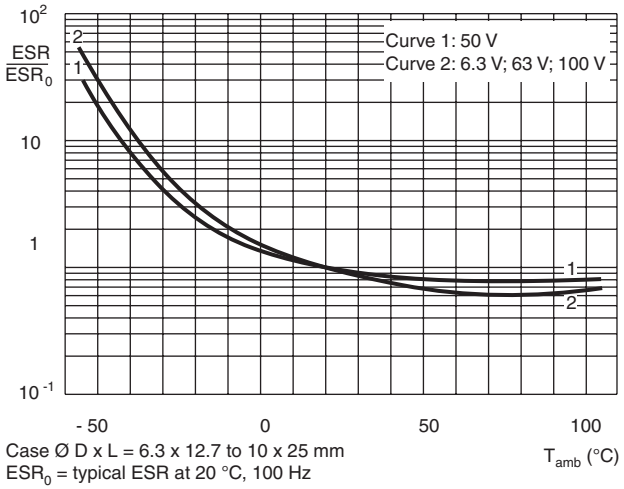


Fig.9 Typical multiplier of ESR as a function of ambient temperature

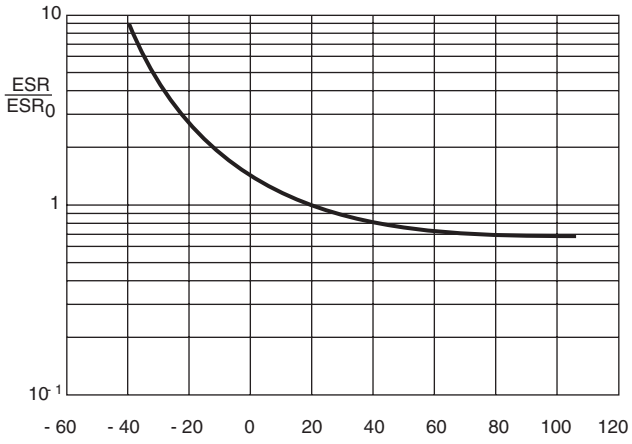


Fig.10 Typical multiplier of ESR as a function of ambient temperature

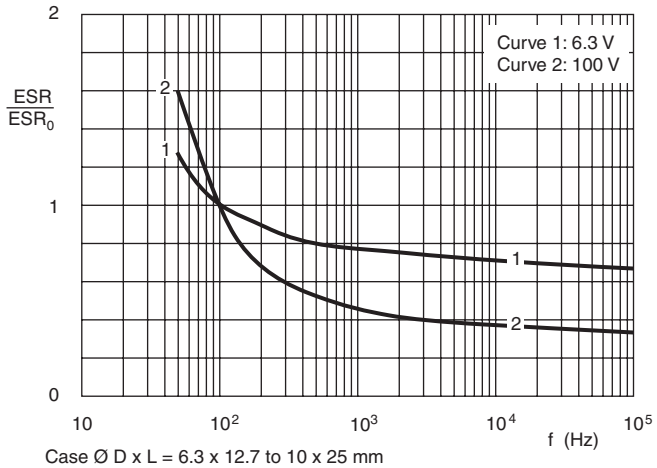
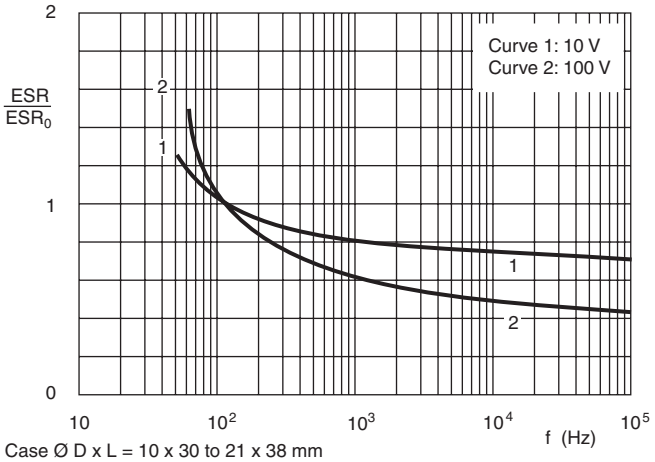


Fig.11 Typical multiplier ESR as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)



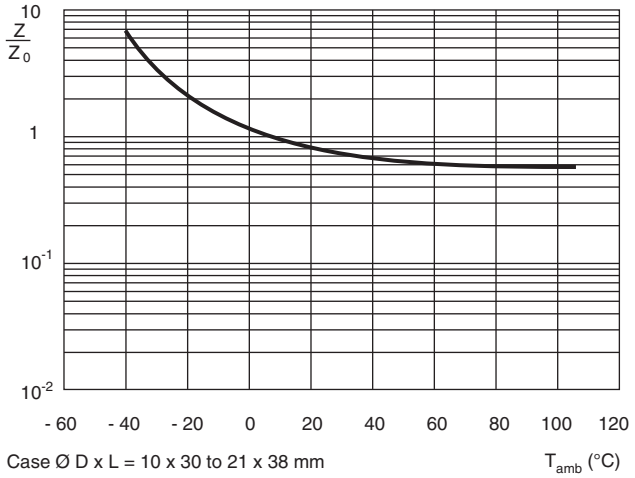
Case Ø D x L = 10 x 30 to 21 x 38 mm
ESR_0 = typical ESR at 20 °C, 100 Hz

Fig.12 Typical multiplier ESR as a function of frequency

IMPEDANCE (Z)

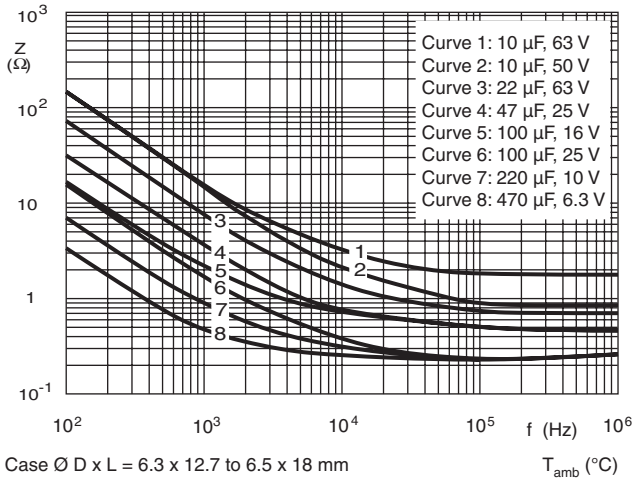
Table 4

IMPEDANCE VS. CAPACITANCE VALUES (case Ø D x L = 6.3 x 12.7 to 10 x 25 mm)								
T_{amb}	**Z x C_R (Ω x µF) AT 10 kHz**							
	6.3 V	**10 V**	**16 V**	**25 V**	**40 V**	**50 V**	**63 V**	**100 V**
+ 20 °C	≤ 300	≤ 200	≤ 160	≤ 120	≤ 90	≤ 70	≤ 80	≤ 80
- 25 °C	≤ 2000	≤ 1200	≤ 750	≤ 560	≤ 450	≤ 300	≤ 550	≤ 550
- 40 °C	≤ 5500	≤ 3200	≤ 2000	≤ 1500	≤ 1200	≤ 900	≤ 1500	≤ 1500



Case Ø D x L = 10 x 30 to 21 x 38 mm

Fig.13 Typical multiplier of ESR as a function of ambient temperature at 10 kHz



Case Ø D x L = 6.3 x 12.7 to 6.5 x 18 mm

T_{amb} (°C)

Fig.14 Typical impedance as a function of frequency

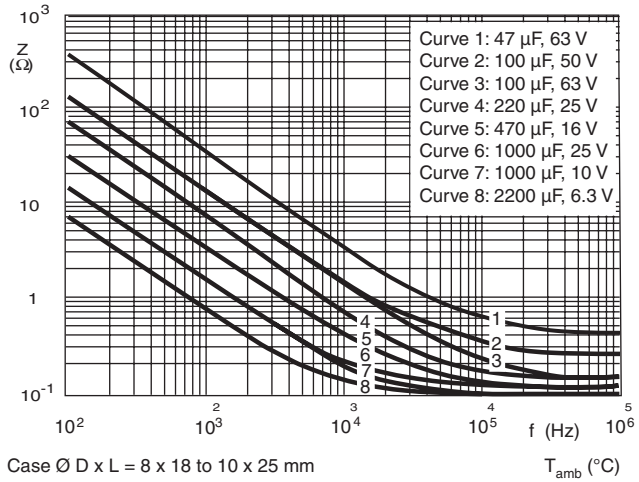


Fig.15 Typical impedance as a function of frequency

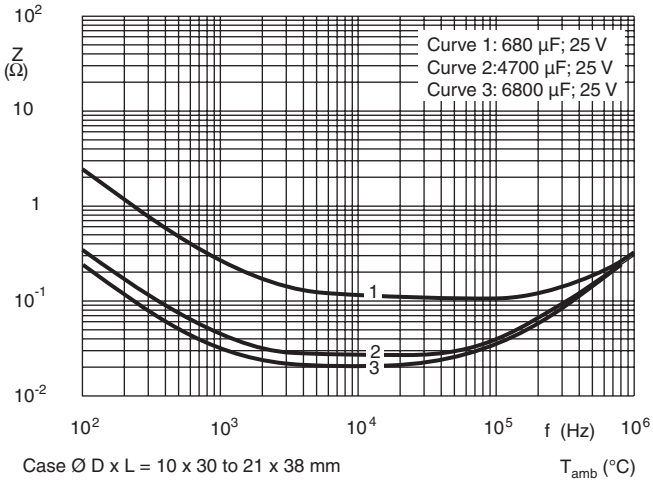


Fig.16 Typical impedance as a function of frequency

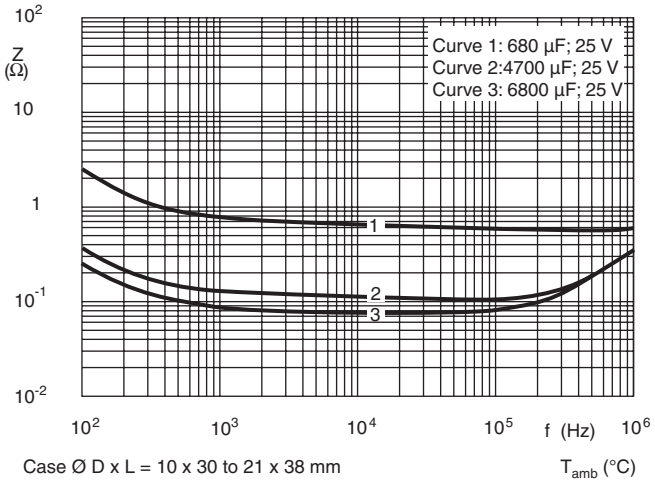


Fig.17 Typical impedance as a function of frequency

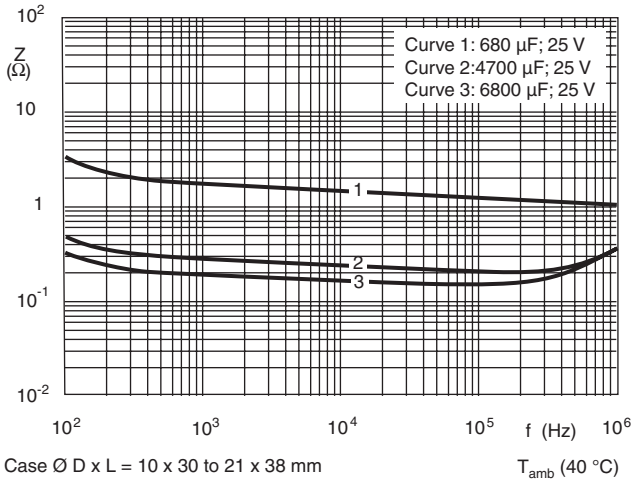
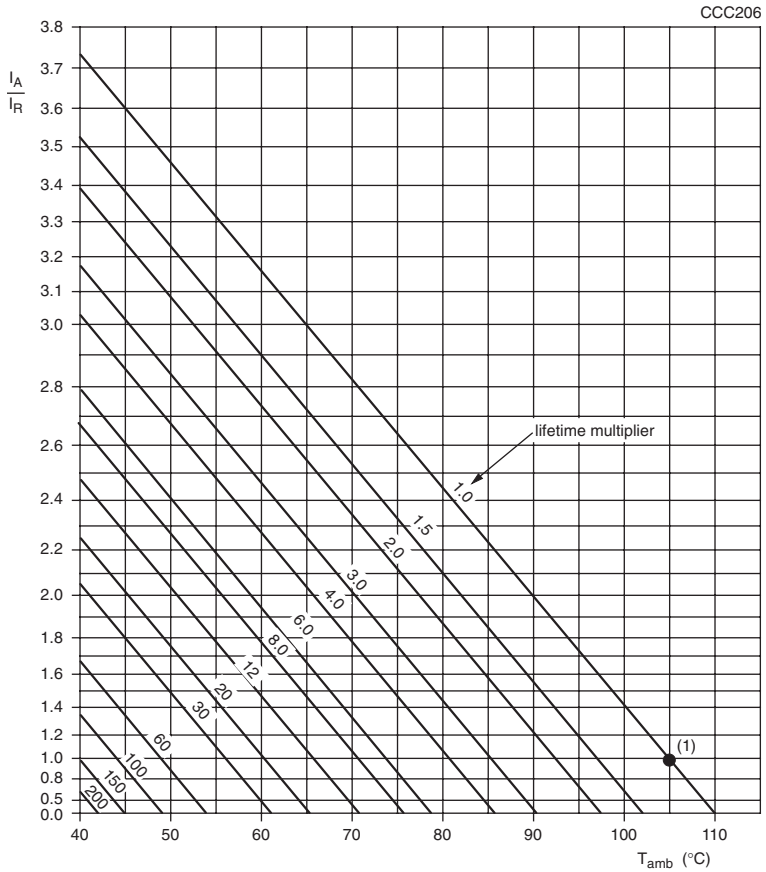


Fig.18 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz

I_R = rated ripple current at 100 Hz, 105 °C

(1) Useful life at 105 °C and I_R applied:
case Ø D x L = 6.3 x 12.7 to 10 x 25 mm: 2000 hours
case Ø D x L = 10 x 30 to 21 x 38 mm: 10 000 hours

Fig.19 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 25 V	U_R = 40 to 100 V
50	0.95	0.90	0.85
100	1.00	1.00	1.00
300	1.07	1.12	1.20
1000	1.12	1.20	1.30
3000	1.15	1.25	1.35
≥ 10 000	1.20	1.30	1.40

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; case Ø D x L: 6.3 x 12.7 to 10 x 25 mm: 1000 hours; 10 x 30 to 21 x 38 mm: 5000 hours	$U_R \leq$ 6.3 V; $\Delta C/C$: + 15/- 30 % $U_R >$ 6.3 V; $\Delta C/C$: ± 15 % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; case Ø D x L: 6.3 x 12.7 to 10 x 25 mm: 2000 hours; 10 x 30 to 21 x 38 mm: 10 000 hours	$U_R \leq$ 6.3 V; $\Delta C/C$: + 45/- 50 % $U_R >$ 6.3 V; $\Delta C/C$: ± 45 % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	T_{amb} = 105 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq$ 2 x spec. limit

Aluminum Capacitors
Axial Long Life, DIN-Based

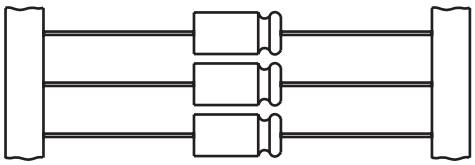
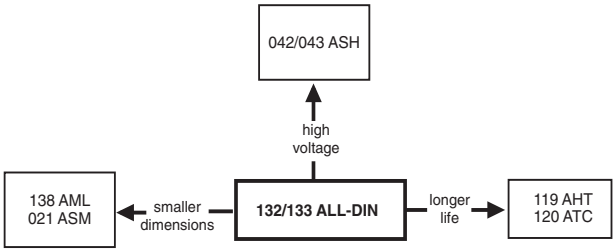


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Long useful life: up to 10 000 to 15 000 hours at 85 °C, high reliability
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

- General industrial, power supplies, telecommunication, EDP
- Coupling, decoupling, timing; smoothing, filtering and buffering in SMPS
- For use where low mounting height is important
- Vibration and shock resistant

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for - 10 to + 50 %)
- Rated voltage (in V)
- Upper category temperature (85 °C)
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number (132 or 133)

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
Nominal case sizes (Ø D x L in mm)	6.5 x 18 and 8 x 18	10 x 18 and 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	1 to 4700 µF		
Tolerance on C_R	- 10 to + 50 %		
Rated voltage range, U_R	10 to 350 V		
Category temperature range	- 40 to + 85 °C		
Endurance test at 105 °C	2000 hours	2000 hours	-
Endurance test at 85 °C	6000 hours	8000 hours	8000 hours
Useful life at 105 °C	3000 hours	3000 hours	-
Useful life at 85 °C	10 000 hours	15 000 hours	15 000 hours
Useful life at 40 °C, 1.8 x I_R applied	160 000 hours	240 000 hours	240 000 hours
Shelf life at 0 V, 85 °C	500 hours		
Based on sectional specification	IEC 60384-4/EN130300		
Climatic category IEC 60068	40/085/56		

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)								
	10	16	25	40	63	100	160	250	350
1.0	-	-	-	-	-	6.5 x 18	-	-	6.5 x 18
2.2	-	-	-	-	-	6.5 x 18	6.5 x 18	8 x 18	8 x 18
4.7	-	-	-	-	6.5 x 18	6.5 x 18	8 x 18	10 x 18	8 x 18
10	-	-	-	-	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30 (1)
	-	-	-	-	-	-	-	10 x 30 (1)	-
22	-	-	6.5 x 18	-	8 x 18	10 x 18	10 x 25	12.5 x 30 (1)	-
	-	-	-	-	-	-	10 x 30 (1)	-	-

Note

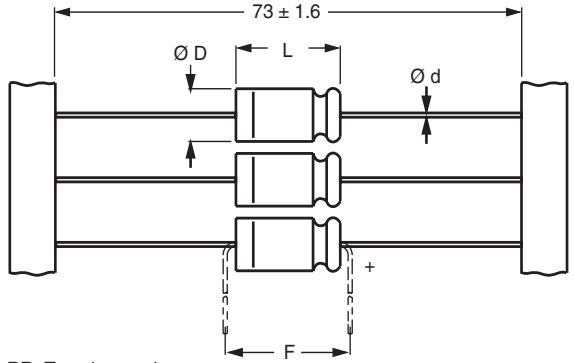
(1) For these CV-values see data sheet 041 - 043 ASH.

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D X L in mm)									
C_R (µF)	U_R (V)								
	10	16	25	40	63	100	160	250	350
47	-	6.5 x 18	-	8 x 18	10 x 18	10 x 25	15 x 30 (1)	18 x 30 (1)	18 x 38 (1)
	-	-	-	-	-	10 x 30	-	-	-
68	-	-	-	-	10 x 30	12.5 x 30	15 x 30 (1)	18 x 38 (1)	21 x 38 (1)
100	-	8 x 18	-	10 x 18	10 x 30	15 x 30	18 x 30 (1)	21 x 38 (1)	-
150	-	-	-	12.5 x 30	15 x 30	18 x 30	18 x 38 (1)	-	-
220	8 x 18	10 x 18	10 x 25	12.5 x 30	15 x 30	18 x 38	21 x 38 (1)	-	-
	-	-	12.5 x 30	-	-	-	-	-	-
330	-	10 x 25	12.5 x 30	15 x 30	18 x 30	18 x 38	-	-	-
	-	12.5 x 30	-	-	-	-	-	-	-
470	12.5 x 30	10 x 25	12.5 x 30	15 x 30	18 x 38	21 x 38	-	-	-
	-	12.5 x 30	-	-	-	-	-	-	-
680	12.5 x 30	15 x 30	18 x 30	18 x 30	21 x 38	-	-	-	-
1000	15 x 30	15 x 30	18 x 30	18 x 38	21 x 38	-	-	-	-
1500	18 x 30	18 x 30	18 x 38	21 x 38	-	-	-	-	-
2200	18 x 30	18 x 38	21 x 38	21 x 38	-	-	-	-	-
3300	18 x 38	21 x 38	-	-	-	-	-	-	-
4700	21 x 38	21 x 38	-	-	-	-	-	-	-

Note

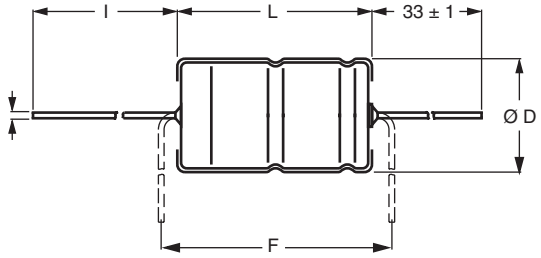
(1) For these CV-values see data sheet 041 - 043 ASH.

DIMENSIONS IN MILLIMETERS AND AVAILABLE FORMS



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm
Form BA: Taped in box (ammopack)
case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.3 **Forms BA and BR**



Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

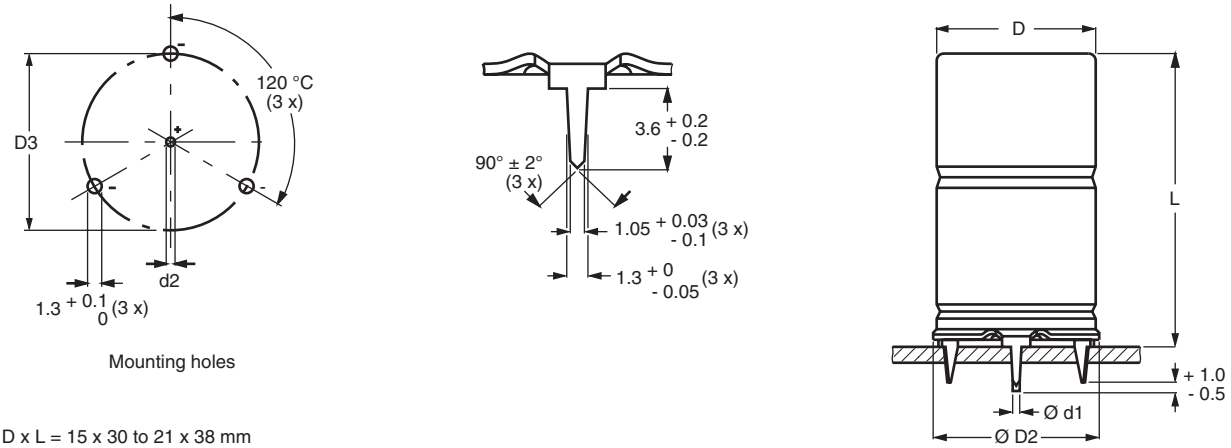
Fig.3 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES										
NOMINAL CASE SIZE Ø D x L	CASE CODE	AXIAL FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		Ø d	l	Ø $D_{max.}$	$L_{max.}$	$F_{min.}$		FORM AA	FORM BA	FORM BR
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note

Detailed tape dimensions see section 'PACKAGING'.



Mounting holes

Case Ø D x L = 15 x 30 to 21 x 38 mm
Case not insulated (insulation on request)
Especially for applications with severe shocks and vibrations

Fig.5 Mounting hole digram and outline; **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters**, MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**MOUNTING RING: FORM MR**						**MASS (g)**	**PACKAGING QUANTITIES**
		Ø d1	**Ø d2**	**Ø $D_{max.}$**	**Ø $D2_{max.}$**	**D3**	**$L_{max.}$**		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 12.9	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 19.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 24.0	100

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance - 10/+ 50 %
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 132 series

100 µF/40 V; - 10/+ 50 %

Nominal case size: Ø 10 x 18 mm; Form BR

Ordering code: MAL213227101E3
Former 12NC: 2222 132 27101

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2.....			
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	220	8 x 18	190	8.4	0.18	1.3	0.73	0.70	-	13224221E3	13234221E3	-
	470	12.5 x 30	350	9.4	0.18	0.61	0.26	0.60	13214471E3	13224471E3	-	-
	680	12.5 x 30	460	13.6	0.18	0.42	0.20	0.40	13214681E3	13224681E3	-	-
	1000	15 x 30	640	20	0.18	0.28	0.12	-	13214102E3	13224102E3	-	13244102E3
	1500	18 x 30	800	30	0.22	0.23	0.10	-	13214152E3	-	-	13244152E3
	2200	18 x 30	1100	44	0.22	0.16	0.09	-	13214222E3	-	-	13244222E3
	3300	18 x 38	1300	66	0.27	0.13	0.05	-	13214332E3	-	-	13244332E3
	4700	21 x 38	1800	94	0.27	0.09	0.05	-	13214472E3	-	-	13244472E3
16	47	6.5 x 18	95	5.5	0.14	4.7	2.6	2.2	-	13225479E3	13235479E3	-
	100	8 x 18	150	7.2	0.14	2.2	1.2	1.1	-	13225101E3	13235101E3	-
	220	10 x 18	250	11	0.14	1.0	0.55	0.55	-	13225221E3	13235221E3	-
	330	10 x 25	320	14.6	0.14	0.67	0.36	0.36	-	13290508E3	13290509E3	-
	330	12.5 x 30	320	10.6	0.14	0.67	0.36	0.60	13215331E3	13225331E3	-	-
	470	10 x 25	450	19	0.14	0.47	0.26	0.26	-	13290507E3	13290502E3	-
	470	12.5 x 30	450	15	0.14	0.47	0.26	0.40	13215471E3	13225471E3	-	-
	680	15 x 30	550	22	0.14	0.33	0.14	-	13215681E3	13225681E3	-	13245681E3
	1000	15 x 30	780	32	0.14	0.22	0.12	-	13215102E3	13225102E3	-	13245102E3
	1500	18 x 30	950	48	0.15	0.16	0.10	-	13215152E3	-	-	13245152E3
	2200	18 x 38	1300	70	0.15	0.11	0.06	-	13215222E3	-	-	13245222E3
	3300	21 x 38	1600	110	0.15	0.07	0.05	-	13215332E3	-	-	13245332E3
	4700	21 x 38	2300	150	0.15	0.05	0.05	-	13215472E3	-	-	13245472E3
25	22	6.5 x 18	60	5.1	0.11	8.0	4.1	2.9	-	13226229E3	13236229E3	-
	220	10 x 25	340	15	0.11	0.8	0.40	0.40	-	13290503E3	13290504E3	-
	220	12.5 x 30	340	11	0.11	0.8	0.40	0.60	13216221E3	13226221E3	-	-
	330	12.5 x 30	410	16.5	0.11	0.53	0.30	0.40	13216331E3	13226331E3	-	-
	470	12.5 x 30	560	24	0.11	0.37	0.20	-	13216471E3	13226471E3	-	-
	680	18 x 30	700	34	0.11	0.26	0.10	-	13216681E3	-	-	13246681E3
	1000	18 x 30	1000	50	0.11	0.17	0.10	-	13216102E3	-	-	13246102E3
	1500	18 x 38	1100	75	0.12	0.13	0.06	-	13216152E3	-	-	13246152E3
	2200	21 x 38	1850	110	0.13	0.09	0.05	-	13216222E3	-	-	13246222E3
40	47	8 x 18	120	7.8	0.09	3.0	1.6	1.4	-	13227479E3	13237479E3	-
	100	10 x 18	210	12	0.09	1.4	0.75	0.75	-	13227101E3	13237101E3	-
	150	10 x 25	310	16	0.09	0.95	0.50	0.50	-	13290511E3	13290512E3	-
	150	12.5 x 30	310	12	0.09	0.95	0.50	0.60	13217151E3	13227151E3	-	-
	220	12.5 x 30	410	17.5	0.09	0.65	0.34	0.40	13217221E3	13227221E3	-	-
	330	15 x 30	550	26	0.09	0.43	0.20	-	13217331E3	13227331E3	-	13247331E3
	470	15 x 30	700	38	0.09	0.30	0.16	-	13217471E3	13227471E3	-	13247471E3
	680	18 x 30	900	54	0.09	0.21	0.10	-	13217681E3	-	-	13247681E3
	1000	18 x 38	1200	80	0.09	0.14	0.08	-	13217102E3	-	-	13247102E3
	1500	21 x 38	1500	120	0.10	0.10	0.06	-	13217152E3	-	-	13247152E3
	2200	21 x 38	1900	180	0.10	0.07	0.05	-	13217222E3	-	-	13247222E3
63	4.7	6.5 x 18	38	4.6	0.07	24	12	5	-	13228478E3	13238478E3	-
	10	6.5 x 18	64	5.3	0.07	11	5.5	3.3	-	13228109E3	13238109E3	-
	22	8 x 18	100	6.8	0.07	5.1	2.5	2.1	-	13228229E3	13238229E3	-
	47	10 x 18	170	9.9	0.07	2.4	1.2	1.2	-	13228479E3	13238479E3	-
	68	10 x 25	210	12.6	0.07	1.6	0.81	0.60	-	13290513E3	13290514E3	-
	68	10 x 30	210	8.6	0.07	1.6	0.80	0.60	13218689E3	13228689E3	-	-
	100	10 x 30	300	12.6	0.07	1.1	0.60	0.40	13218101E3	13228101E3	-	-
	150	15 x 30	350	19	0.07	0.74	0.37	-	13218151E3	13228151E3	-	13248151E3
	220	15 x 30	520	28	0.07	0.50	0.25	-	13218221E3	13228221E3	-	13248221E3
	330	18 x 30	600	42	0.07	0.34	0.15	-	13218331E3	-	-	13248331E3
	470	18 x 38	970	59	0.07	0.24	0.12	-	13218471E3	-	-	13248471E3
	680	21 x 38	1000	86	0.07	0.16	0.08	-	13218681E3	-	-	13248681E3
	1000	21 x 38	1600	130	0.07	0.11	0.06	-	13218102E3	-	-	13248102E3

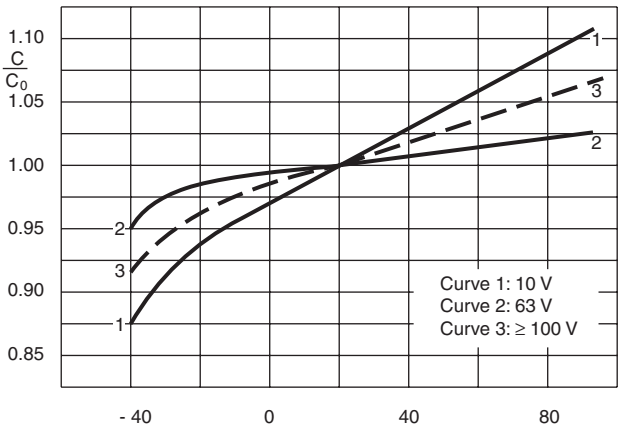
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2.....			
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
100	1	6.5 x 18	20	4.0	0.06	95	45	6	-	13229108E3	13239108E3	-
	2.2	6.5 x 18	30	4.4	0.06	43	20	5	-	13229228E3	13239228E3	-
	4.7	6.5 x 18	48	4.9	0.06	20	9.6	4	-	13229478E3	13239478E3	-
	10	8 x 18	73	6	0.06	9.5	4.5	2.8	-	13229109E3	13239109E3	-
	22	10 x 18	130	8.4	0.06	4.3	2	1.3	-	13229229E3	13239229E3	-
	47	10 x 25	220	13.4	0.06	2.0	1	0.90	-	13290505E3	13290506E3	-
	47	10 x 30	220	9.4	0.06	2.0	1	0.90	13219479E3	13229479E3	-	-
	68	12.5 x 30	250	13.5	0.06	1.4	0.80	-	13219689E3	13229689E3	-	-
	100	15 x 30	380	20	0.06	0.95	0.50	-	13219101E3	13229101E3	-	13249101E3
	150	18 x 30	400	30	0.06	0.64	0.35	-	13219151E3	-	-	13249151E3
	220	18 x 38	660	44	0.06	0.43	0.20	-	13219221E3	-	-	13249221E3
	330	18 x 38	700	66	0.06	0.29	0.15	-	13219331E3	-	-	13249331E3
	470	21 x 38	1200	94	0.06	0.20	0.10	-	13219471E3	-	-	13249471E3
160	2.2	6.5 x 18	22	20	0.10	72	55	30	-	13321228E3	13331228E3	-
	4.7	8 x 18	37	20	0.10	34	26	20	-	13321478E3	13331478E3	-
	10	10 x 18	61	20	0.10	16	12	10	-	13321109E3	13331109E3	-
	22	10 x 25	120	20	0.10	7.2	5.5	2.5	-	13390502E3	13390503E3	-
250	2.2	8 x 18	25	20	0.10	72	50	30	-	13323228E3	13333228E3	-
	4.7	10 x 18	37	20	0.10	34	23	16	-	13323478E3	13333478E3	-
	10	10 x 25	66	20	0.10	16	11	9	-	13323109E3	13333109E3	-
350	1	6.5 x 18	15	20	0.10	160	100	40	-	13325108E3	13335108E3	-
	2.2	8 x 18	25	20	0.10	72	45	28	-	13325228E3	13335228E3	-
	4.7	8 x 18	43	20	0.10	34	21	15	-	13390511E3	13390509E3	-

ADDITIONAL ELECTRICAL DATA

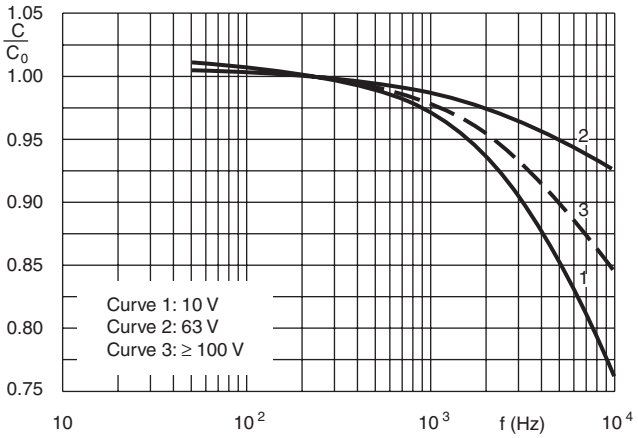
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage	U_R = 10 to 250 V	$U_s \leq 1.15 \times U_R$	
	U_R = 350 V	$U_s \leq 1.1 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	After 1 minute:		
	Case Ø D x L = 6.5 x 18 to 10 x 25 mm:		
	U_R = 10 to 100 V	$I_{L1} \leq 0.01\ C_R \times U_R + 3$	
	U_R = 160 to 350 V	$I_{L1} \leq 50$ µA	
	Case Ø D x L = 10 x 30 to 21 x 38 mm:		
	U_R = 10 to 100 V	$I_{L1} \leq 0.006\ C_R \times U_R + 3$	
	After 5 minutes:		
	Case Ø D x L = 6.5 x 18 to 10 x 25 mm:		
	U_R = 10 to 100 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4$	
	U_R = 160 to 350 V	$I_{L5} \leq 20$ µA	
	Case Ø D x L = 10 x 30 to 21 x 38 mm:		
	U_R = 10 to 100 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA	
Inductance			
Equivalent series inductance (ESL)	Case Ø D x L mm:		
	6.5 x 18	typ. 15 nH	-
	8 x 18	typ. 35 nH	-
	10 x 18	typ. 69 nH	-
	10 x 25	typ. 38 nH	-
	10 x 30	typ. 38 nH	-
	12.5 x 30	typ. 46 nH	-
	15 x 30	typ. 48 nH	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100 Hz

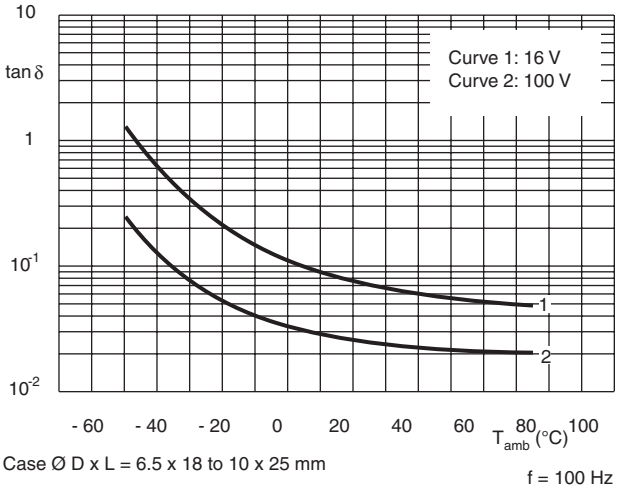
Fig.5 Typical multiplier of capacitance as a function of ambient temperature at 10 kHz



C_0 = capacitance at 20 °C, 100 Hz

Fig.6 Typical multiplier of capacitance as a function of frequency

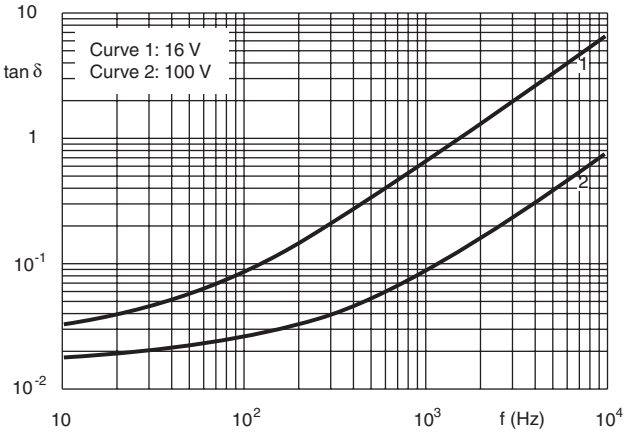
DISSIPATION FACTOR (tan δ)



Case Ø D x L = 6.5 x 18 to 10 x 25 mm

f = 100 Hz

Fig.7 Typical tan δ as a function of ambient temperature



Case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.8 Typical tan δ as a function of frequency

IMPEDANCE (Z)

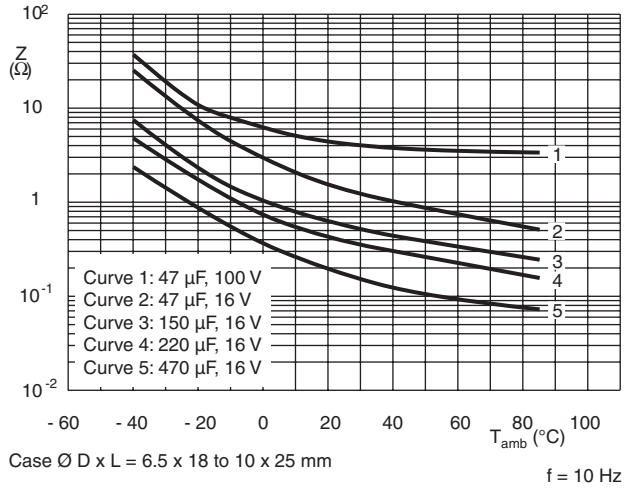


Fig.9 Typical impedance as a function of ambient temperature

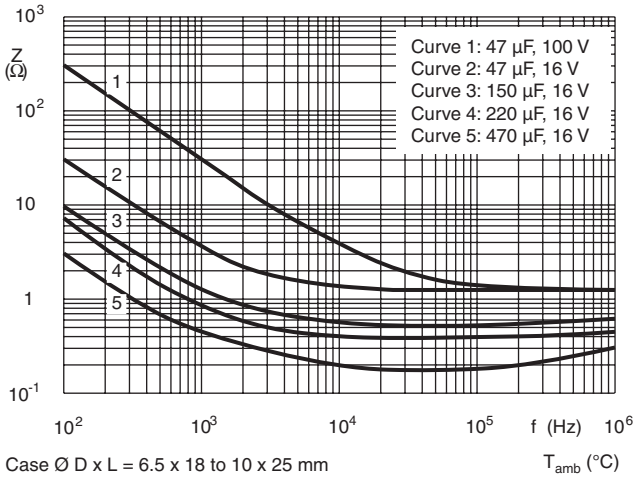
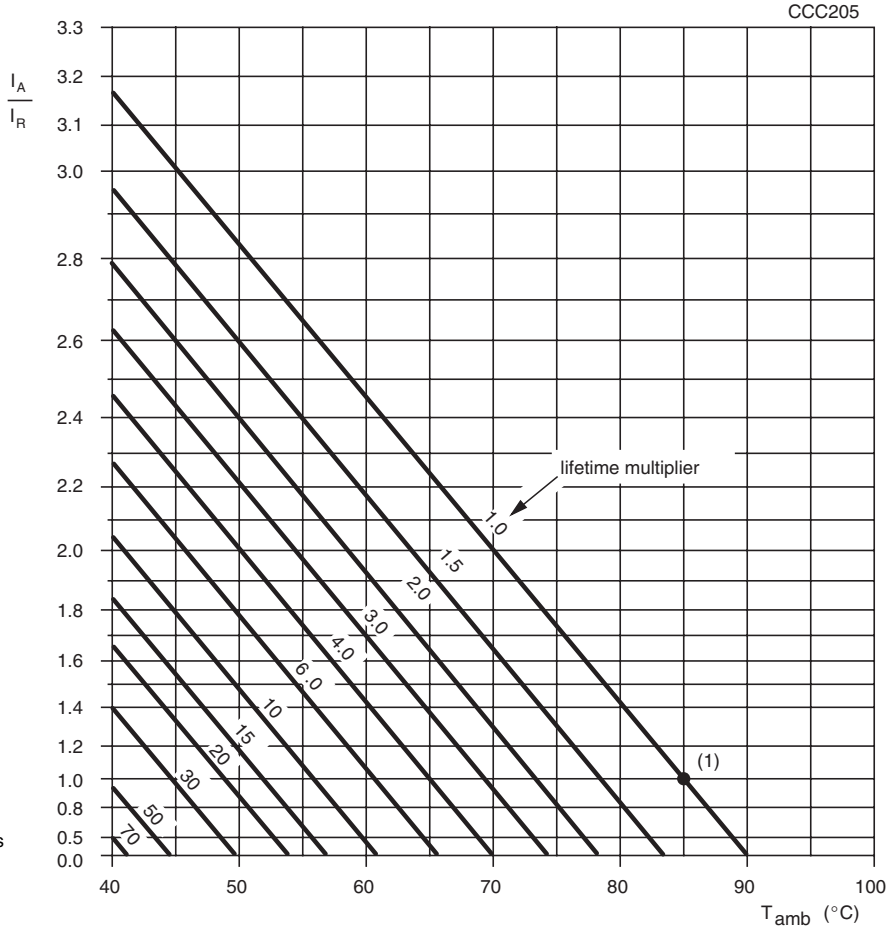


Fig.10 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 85 °C

(1) Useful life at 85 °C and I_R applied:
case ∅ D x L = 6.5 x 18 to 8 x 18 mm: 10 000 hours
case ∅ D x L = 10 x 18 to 21 x 38 mm: 15 000 hours

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 and 16 V	U_R = 25 and 63 V	U_R = 100 to 350 V
50	0.95	0.90	0.85
100	1.00	1.00	1.00
300	1.07	1.12	1.20
1000	1.12	1.20	1.30
3000	1.15	1.25	1.35
≥ 10 000	1.20	1.30	1.40

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; Case Ø D x L = 6.5 x 18 to 8 x 18 mm: 6000 hours; Case Ø D x L = 10 x 18 to 21 x 38 mm: 8000 hours	U_R = 10 to 160 V; ΔC/C: ± 15 % U_R = 250 to 350 V; ΔC/C: ± 10 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; Case Ø D x L = 6.5 x 18 to 8 x 18 mm: 10 000 hours; Case Ø D x L = 10 x 18 to 21 x 38 mm: 15 000 hours	U_R = 10 to 160 V; ΔC/C: ± 45 % U_R = 250 to 350 V; ΔC/C: ± 30 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours; After test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_{L5} ≤ 2 x spec. limit

Aluminum Capacitors
Axial High Temperature

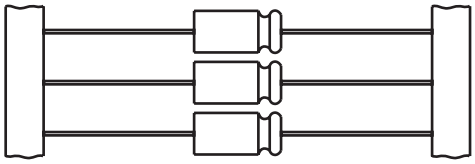
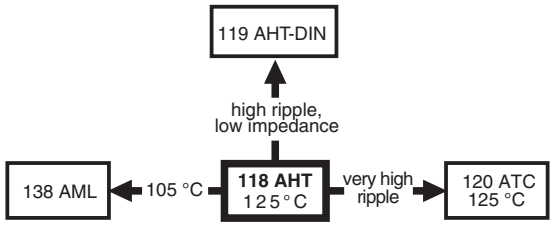


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion.
- Charge and discharge proof
- Extra long useful life: up to 8000 hours at 125 °C, high reliability
- Extended temperature range: 125 °C (usable up to 150 °C)
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

- Automotive, industrial and telecommunication
- Smoothing, filtering, coupling, decoupling, timing
- For use after very long storage (10 years) without voltage applied
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration and shock resistant
- Outdoor applications, e.g. aerial amplifiers

MARKING

The capacitors are marked (where possible) with the following information:

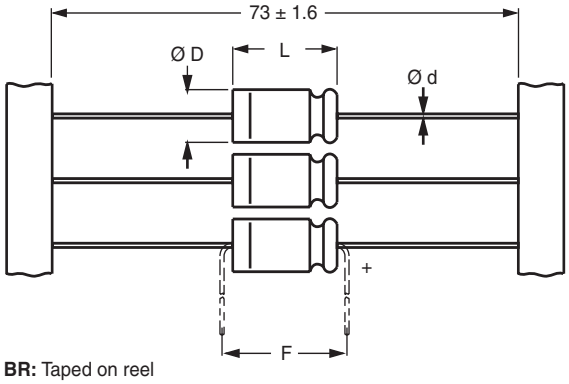
- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V) at 125 °C and 85 °C
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number (118)

QUICK REFERENCE DATA		
DESCRIPTION	**VALUE**	
Nominal case sizes (Ø D x L in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	1 to 10 000 µF	
Tolerance on C_R	± 20 %	
Rated voltage range, U_R	6.3 to 200 V	
Category temperature range	- 40 to + 125 °C	- 55 to + 125 °C
Endurance test at 150 °C (6.3 to 100 V)	500 hours	500 hours
Endurance test at 125 °C	2000 hours	3000 hours
Useful life at 125 °C	4000 hours	8000 hours
Useful life at 40 °C, 1.8 x I_R applied	500 000 hours	1 000 000 hours
Shelf life at 0 V, 125 °C:		
U_R = 6.3 to 63 V	500 hours	
U_R = 100 and 200 V	100 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/125/56	55/125/56

For technical questions, contact: aluminumcaps1@vishay.com
Document Number: 28334
Revision: 30-May-08

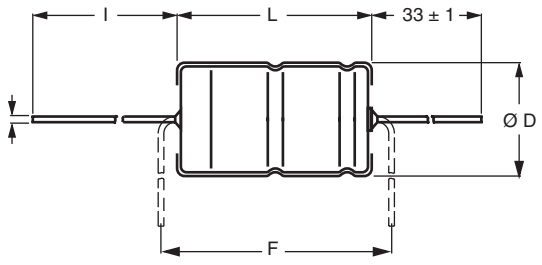
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (∅ D x L in mm)								
C_R (µF)	U_R (V)							
	6.3	10	16	25	40	63	100	200
1.0	-	-	-	-	-	6.5 x 18	-	-
2.2	-	-	-	-	-	6.5 x 18	-	6.5 x 18
4.7	-	-	-	-	-	6.5 x 18	6.5 x 18	8 x 18
10	-	-	-	-	-	6.5 x 18	6.5 x 18	10 x 25
15	-	-	-	-	-	-	-	10 x 30
22	-	-	-	-	-	6.5 x 18	8 x 18	12.5 x 30
33	-	-	-	-	-	-	10 x 25	15 x 30
47	-	-	-	-	6.5 x 18	8 x 18	10 x 25	18 x 30
	-	-	-	-	-	-	10 x 30	-
68	-	-	-	-	-	-	12.5 x 30	18 x 38
100	-	-	-	6.5 x 18	8 x 18	10 x 25	12.5 x 30	21 x 38
	-	-	-	-	-	10 x 30	-	-
150	-	-	-	-	10 x 18	12.5 x 30	15 x 30	-
220	-	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30	18 x 30	-
	-	-	-	-	10 x 30	-	-	-
330	-	8 x 18	10 x 18	10 x 25	12.5 x 30	15 x 30	18 x 38	-
470	-	8 x 18	10 x 18	10 x 25	12.5 x 30	18 x 30	21 x 38	-
	-	-	-	10 x 30	-	-	-	-
680	-	-	10 x 30	12.5 x 30	15 x 30	18 x 38	-	-
1000	10 x 18	10 x 25	12.5 x 30	12.5 x 30	18 x 30	21 x 38	-	-
	-	10 x 30	-	-	-	-	-	-
1500	10 x 25	12.5 x 30	12.5 x 30	15 x 30	18 x 38	-	-	-
2200	-	12.5 x 30	15 x 30	18 x 30	21 x 38	-	-	-
3300	-	15 x 30	18 x 30	18 x 38	-	-	-	-
4700	-	18 x 30	18 x 38	21 x 38	-	-	-	-
6800	-	18 x 38	21 x 38	-	-	-	-	-
10 000	-	21 x 38	-	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm
Form BA: Taped in box (ammopack)
case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.3 **Forms BA and BR**



Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

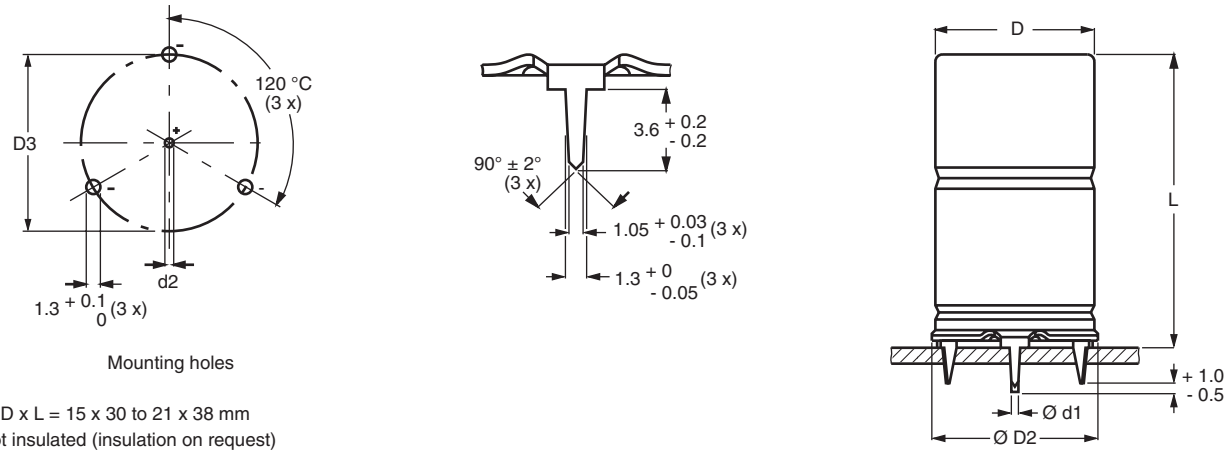
Fig.3 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**										
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**AXIAL: FORM AA, BA and BR**					**MASS (g)**	**PACKAGING QUANTITIES**		
		Ø d	**l**	**Ø $D_{max.}$**	**$L_{max.}$**	**$F_{min.}$**		**FORM AA**	**FORM BA**	**FORM BR**
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note

Detailed tape dimensions see section 'PACKAGING'



Case Ø D x L = 15 x 30 to 21 x 38 mm
Case not insulated (insulation on request)
Especially for applications with severe shocks and vibrations

Fig.4 Mounting hole digram and outline; **Form MR:** With mounting ring and pins

MOUNTING RING; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**MOUNTING RING: FORM MR**						**MASS (g)**	**PACKAGING QUANTITIES**
		Ø d1	**Ø d2**	**Ø $D_{max.}$**	**Ø $D2_{max.}$**	**D3**	**$L_{max.}$**		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 8.6	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 11.5	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 14.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 19.0	100

ELECTRICAL DATA	
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 125 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 118 series

1000 µF/10 V; ± 20 %

Nominal case size: Ø 10 x 30 mm; Form BR

Ordering code: MAL211824102E3
Former 12NC: 2222 118 24102

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2118.....			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
6.3	1000	10 x 18	6	251	42	17	0.50	0.79	0.8	-	23102E3	33102E3	-
	1500	10 x 25	7	352	61	23	0.50	0.53	0.53	-	90502E3	90503E3	-
10	220	6.5 x 18	4	109	20	8.4	0.35	2.53	2.1	-	24221E3	34221E3	-
	330	8 x 18	5	150	24	11	0.35	1.69	1.4	-	24331E3	34331E3	-
	470	8 x 18	5	179	32	13	0.35	1.19	1.0	-	24471E3	34471E3	-
	1000	10 x 25	7	343	64	24	0.35	0.56	0.55	-	90504E3	90505E3	-
	1000	10 x 30	00	550	64	24	0.32	0.505	0.45	14102E3	24102E3	-	-
	1500	12.5 x 30	01	740	94	34	0.32	0.340	0.28	14152E3	24152E3	-	-
	2200	12.5 x 30	01	830	136	48	0.40	0.290	0.27	14222E3	24222E3	-	-
	3300	15 x 30	02	1070	202	70	0.40	0.190	0.18	14332E3	24332E3	-	44332E3
	4700	18 x 30	03	1350	286	98	0.46	0.155	0.15	14472E3	-	-	44472E3
	6800	18 x 38	04	1730	412	140	0.53	0.100	0.10	14682E3	-	-	44682E3
	10000	21 x 38	05	1860	604	200	0.53	0.084	0.10	14103E3	-	-	44103E3
16	220	8 x 18	5	145	25	11	0.25	1.81	1.5	-	25221E3	35221E3	-
	330	10 x 18	6	204	36	15	0.25	1.21	1.2	-	25331E3	35331E3	-
	470	10 x 18	6	243	49	19	0.25	0.85	0.83	-	25471E3	35471E3	-
	680	10 x 30	00	510	69	30	0.22	0.525	0.45	15681E3	25681E3	-	-
	1000	12.5 x 30	01	720	100	36	0.22	0.345	0.28	15102E3	90039E3	-	-
	1500	12.5 x 30	01	790	148	52	0.29	0.305	0.27	15152E3	25152E3	-	-
	2200	15 x 30	02	1010	215	74	0.29	0.205	0.18	15222E3	25222E3	-	45222E3
	3300	18 x 30	03	1300	321	110	0.34	0.165	0.15	15332E3	-	-	45332E3
	4700	18 x 38	04	1670	455	150	0.34	0.105	0.10	15472E3	-	-	45472E3
	6800	21 x 38	05	1790	657	220	0.38	0.088	0.10	15682E3	-	-	45682E3
25	100	6.5 x 18	4	102	20	9	0.18	2.86	2.3	-	26101E3	36101E3	-
	220	10 x 18	6	196	37	15	0.18	1.30	1.25	-	26221E3	36221E3	-
	330	10 x 25	7	274	54	21	0.18	0.87	0.82	-	26331E3	36331E3	-
	470	10 x 25	7	327	75	28	0.18	0.61	0.57	-	90508E3	90509E3	-
	470	10 x 30	00	490	75	28	0.18	0.61	0.50	16471E3	26471E3	-	-
	680	12.5 x 30	01	680	106	38	0.18	0.42	0.30	16681E3	26681E3	-	-
	1000	12.5 x 30	01	760	154	54	0.24	0.375	0.28	16102E3	26102E3	-	-
	1500	15 x 30	02	980	229	79	0.25	0.263	0.22	16152E3	26152E3	-	46152E3
	2200	18 x 30	03	1240	334	110	0.26	0.185	0.17	16222E3	-	-	46222E3
	3300	18 x 38	04	1610	499	170	0.26	0.12	0.11	16332E3	-	-	46332E3
	4700	21 x 38	05	1710	709	240	0.28	0.095	0.10	16472E3	-	-	46472E3
40	47	6.5 x 18	4	89.8	20	7.8	0.11	3.72	2.8	-	27479E3	37479E3	-
	100	8 x 18	5	147	28	12	0.11	1.75	1.3	-	27101E3	37101E3	-
	150	10 x 18	6	207	40	16	0.11	1.17	1.0	-	27151E3	37151E3	-
	220	10 x 25	7	287	57	22	0.11	0.80	0.68	-	90511E3	90512E3	-
	220	10 x 30	00	390	57	22	0.10	0.70	0.55	17221E3	27221E3	-	-
	330	12.5 x 30	01	570	83	30	0.10	0.43	0.33	17331E3	27331E3	-	-
	470	12.5 x 30	01	620	117	42	0.11	0.38	0.30	17471E3	27471E3	-	-
	680	15 x 30	02	810	167	58	0.11	0.255	0.23	17681E3	27681E3	-	47681E3
	1000	18 x 30	03	1070	244	84	0.13	0.205	0.18	17102E3	-	-	47102E3
	1500	18 x 38	04	1390	364	120	0.13	0.13	0.11	17152E3	-	-	47152E3
	2200	21 x 38	05	1540	532	180	0.15	0.105	0.10	17222E3	-	-	47222E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2118.....			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	1.0	6.5 x 18	4	16.4	20	4.1	0.07	110	22	-	28108E3	38108E3	-
	2.2	6.5 x 18	4	24.3	20	4.3	0.07	51	15	-	28228E3	38228E3	-
	4.7	6.5 x 18	4	35.6	20	4.6	0.07	24	8.9	-	28478E3	38478E3	-
	10	6.5 x 18	4	51.9	20	5.3	0.07	11	5.6	-	28109E3	38109E3	-
	22	6.5 x 18	4	77.0	20	6.8	0.07	5.1	3.2	-	28229E3	38229E3	-
	47	8 x 18	5	126	22	9.9	0.07	2.4	1.5	-	28479E3	38479E3	-
	100	10 x 25	7	243	42	17	0.07	1.1	0.7	-	90513E3	90514E3	-
	100	10 x 30	00	340	42	17	0.07	1.91	1.62	18101E3	28101E3	-	-
	150	12.5 x 30	01	490	61	23	0.07	1.00	0.79	18151E3	28151E3	-	-
	220	12.5 x 30	01	550	87	32	0.08	0.94	0.82	18221E3	28221E3	-	-
	330	15 x 30	02	730	129	46	0.09	0.63	0.56	18331E3	28331E3	-	48331E3
	470	18 x 30	03	970	182	63	0.09	0.44	0.39	18471E3	-	-	48471E3
	680	18 x 38	04	1230	261	90	0.09	0.30	0.26	18681E3	-	-	48681E3
	1000	21 x 38	05	1400	383	130	0.10	0.16	0.20	18102E3	-	-	48102E3
100	4.7	6.5 x 18	4	36	20	4.9	0.07	24	19	-	29478E3	39478E3	-
	10	6.5 x 18	4	52	20	6.0	0.07	11	9.0	-	29109E3	39109E3	-
	22	8 x 18	5	91	20	8.4	0.07	5.1	4.0	-	29229E3	39229E3	-
	33	10 x 25	7	140	24	11	0.07	3.4	2.7	-	29339E3	39339E3	-
	47	10 x 25	7	170	33	13	0.07	2.6	2.0	-	90535E3	90536E3	-
	47	10 x 30	00	240	33	13	0.08	2.6	2.0	19479E3	29479E3	-	-
	68	12.5 x 30	01	320	45	18	0.08	1.8	1.2	19689E3	29689E3	-	-
	100	12.5 x 30	01	380	64	24	0.09	1.4	1.15	19101E3	29101E3	-	-
	150	15 x 30	02	500	94	34	0.10	0.94	0.78	19151E3	29151E3	-	49151E3
	220	18 x 30	03	690	136	48	0.10	0.66	0.55	19221E3	-	-	49221E3
	330	18 x 38	04	890	202	70	0.10	0.45	0.37	19331E3	-	-	49331E3
	470	21 x 38	05	1050	286	98	0.10	0.33	0.28	19471E3	-	-	49471E3
200	2.2	6.5 x 18	4	27	20	4.9	0.06	44	23	-	90537E3	90538E3	-
	4.7	8 x 18	5	46	20	5.9	0.06	21	11	-	90539E3	90541E3	-
	10	10 x 25	7	85	20	8.0	0.06	9.4	5.0	-	90542E3	90543E3	-
	15	10 x 30	00	150	22	10	0.046	4.76	3.75	92159E3	90012E3	-	-
	22	12.5 x 30	01	210	31	13	0.046	3.17	2.22	92229E3	90013E3	-	-
	33	15 x 30	02	290	44	17	0.046	2.11	1.11	92339E3	90014E3	-	90002E3
	47	18 x 30	03	390	61	23	0.046	1.48	0.60	92479E3	-	-	90003E3
	68	18 x 38	04	500	86	31	0.046	1.02	0.42	92689E3	-	-	90004E3
	100	21 x 38	05	610	124	44	0.046	0.96	0.39	92101E3	-	-	90005E3

ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$ or 20 µA (whichever is greater)	
	After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$	
Inductance			
Equivalent series inductance (ESL)	Case ∅ D x L mm:		
	6.5 x 18	typ. 15 nH	-
	8 x 18	typ. 35 nH	-
	10 x 18	typ. 69 nH	-
	10 x 25	typ. 38 nH	-
	10 x 30	typ. 38 nH	-
	12.5 x 30	typ. 46 nH	-
	15 x 30	typ. 48 nH	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

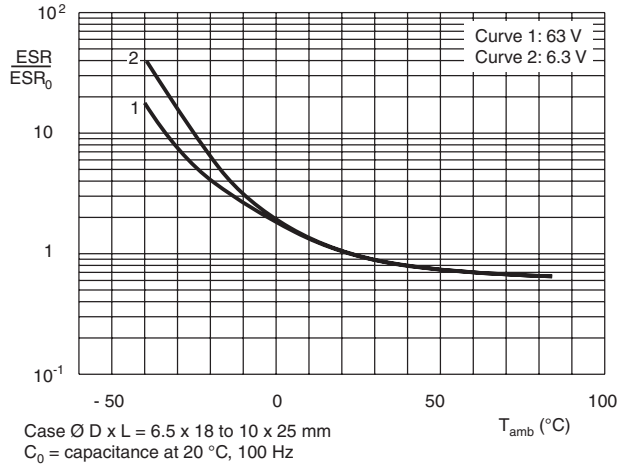
Table 3

UPRATING VALUES AT REDUCED AMBIENT TEMPERATURE										
SYMBOL	CONDITIONS	VALUES								UNIT
U_R	T_{amb} > 85 to 125 °C	6.3	10	16	25	40	63	100	200	V
U_{R2}	$T_{amb} \leq 85$ °C	10	16	25	40	63	100	125	250	V

Note

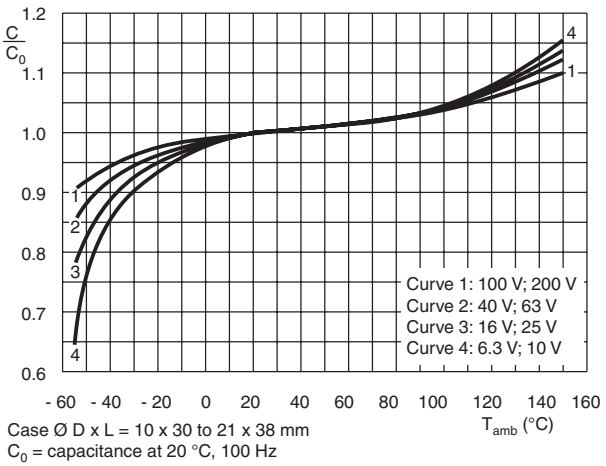
For applications at ambient temperatures of ≤ 85 °C, the rated voltage (U_R) may be raised to U_{R2}.

CAPACITANCE



Case Ø D x L = 6.5 x 18 to 10 x 25 mm
C_0 = capacitance at 20 °C, 100 Hz

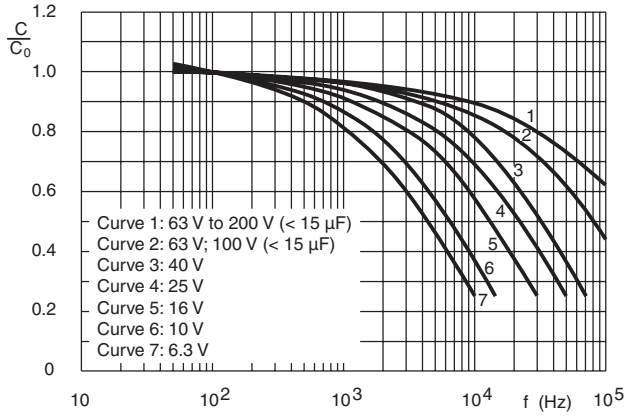
Fig.5 Typical multiplier of capacitance as a function of ambient temperature



Case Ø D x L = 10 x 30 to 21 x 38 mm
C_0 = capacitance at 20 °C, 100 Hz

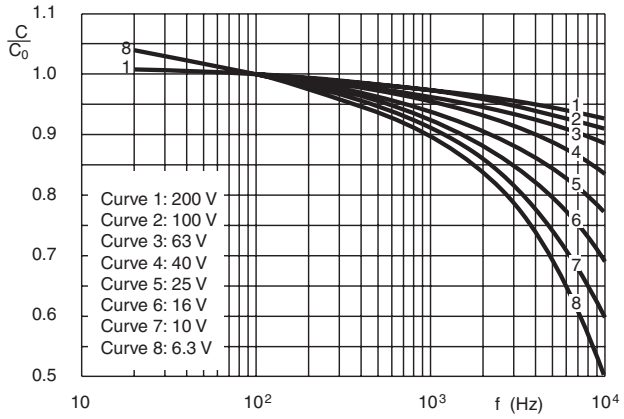
Fig.6 Typical multiplier of capacitance as a function of ambient temperature

CAPACITANCE



Case Ø D x L = 6.5 x 18 to 10 x 25 mm
C_0 = capacitance at 20 °C, 100 Hz

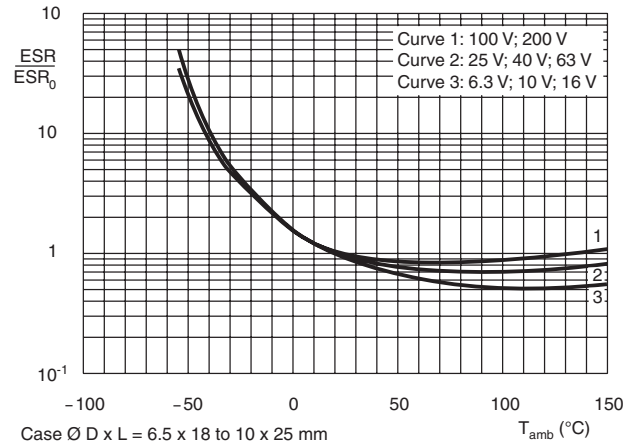
Fig.7 Typical multiplier of capacitance as a function of frequency



Case Ø D x L = 10 x 30 to 21 x 38 mm
C_0 = capacitance at 20 °C, 100 Hz

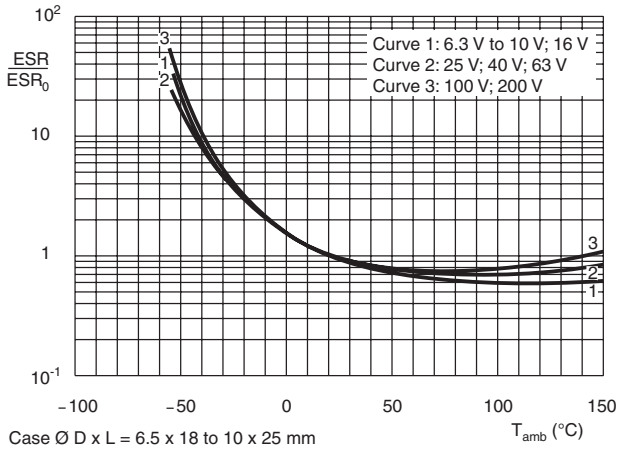
Fig.8 Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)



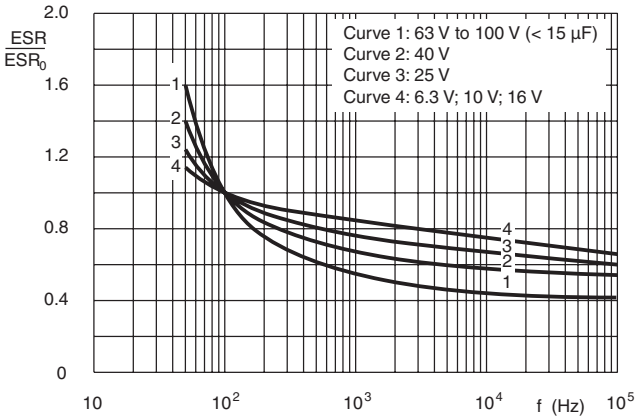
Case Ø D x L = 6.5 x 18 to 10 x 25 mm
ESR_0 = typical at 20 °C, 100 Hz

Fig.9 Typical multiplier of ESR as a function of ambient temperature



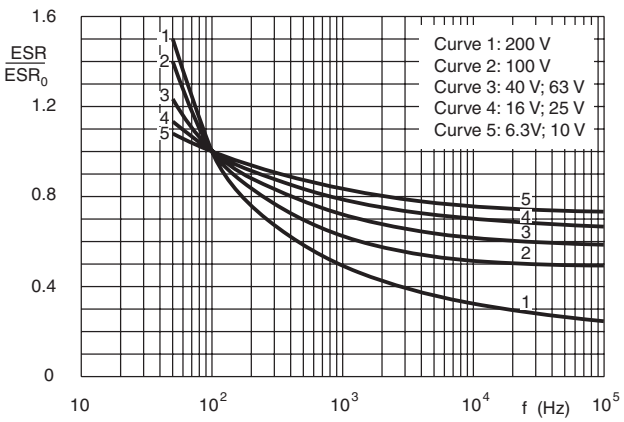
Case Ø D x L = 6.5 x 18 to 10 x 25 mm
ESR_0 = typical at 20 °C, 100 Hz

Fig.10 Typical multiplier of ESR as a function of ambient temperature



Case Ø D x L = 6.5 x 18 to 10 x 25 mm
ESR_0 = typical at 20 °C, 100 Hz

Fig.11 Typical multiplier of ESR as a function of frequency



Case Ø D x L = 10 x 30 to 21x 38 mm
ESR_0 = typical at 20 °C, 100 Hz

Fig.12 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

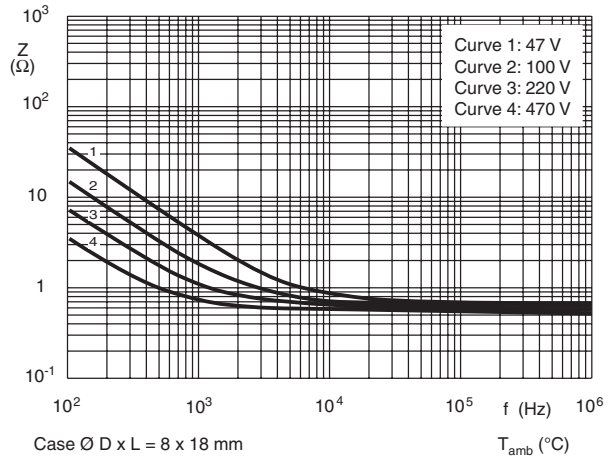


Fig.13 Typical impedance as a function of frequency

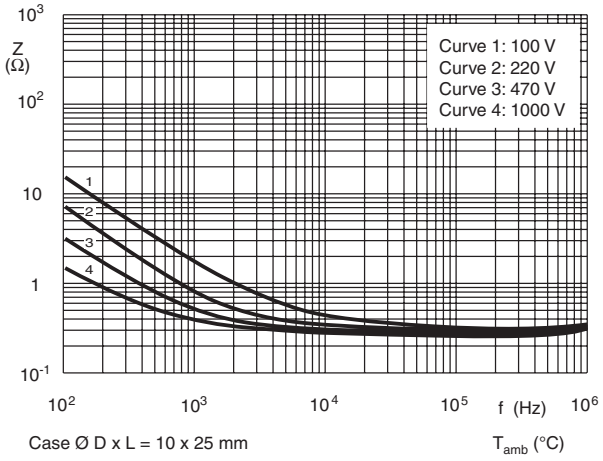


Fig.14 Typical impedance as a function of frequency

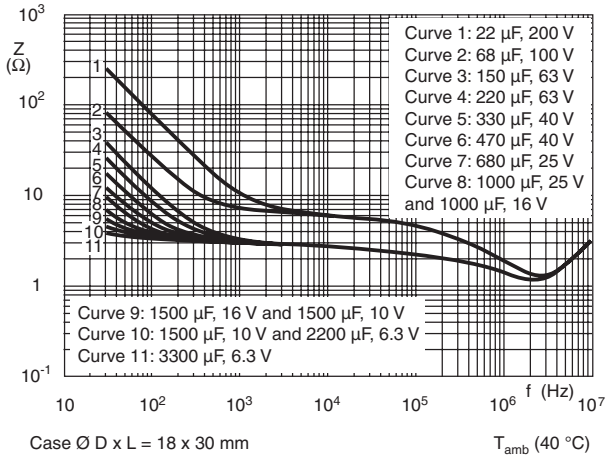


Fig.15 Typical impedance as a function of frequency

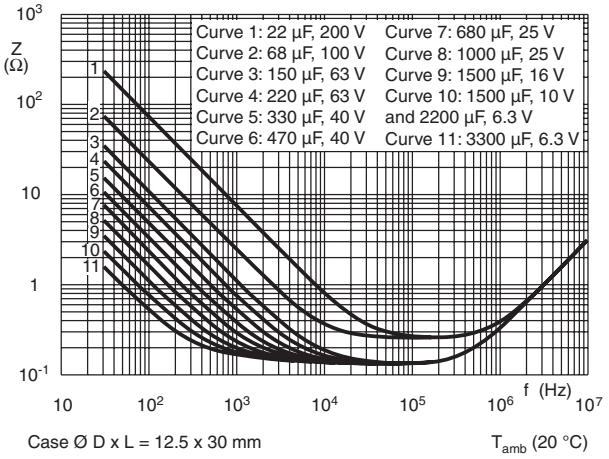


Fig.16 Typical impedance as a function of frequency

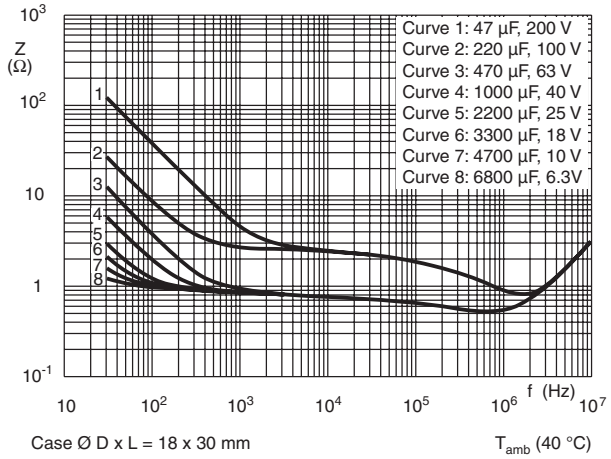


Fig.17 Typical impedance as a function of frequency

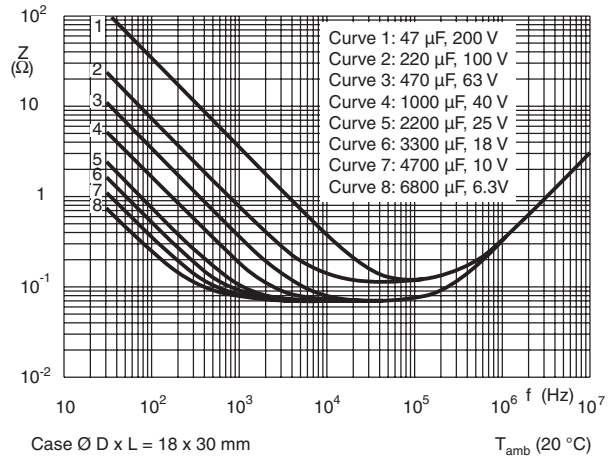
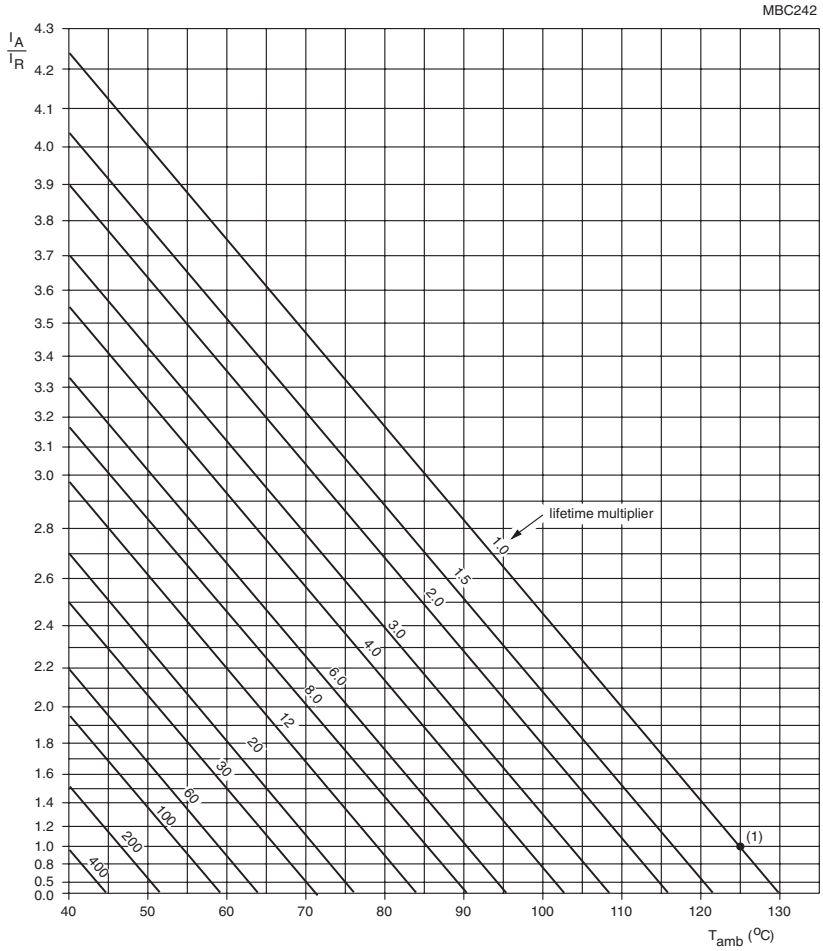


Fig.18 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 125 °C
(1) Useful life at 125 °C and I_R applied:
case Ø D x L = 6.5 x 18 to 10 x 25 mm: 4000 hours
case Ø D x L = 10 x 30 to 21 x 38 mm: 8000 hours

Fig.19 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 40 to 63 V	U_R = 100 to 200 V
50	0.95	0.90	0.85
100	1.00	1.00	1.00
300	1.07	1.12	1.20
1000	1.12	1.20	1.30
3000	1.15	1.25	1.35
≥ 10 000	1.20	1.30	1.40

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R applied; Case sizes: 6.5 x 18 to 10 x 25 mm: 2000 hours; 10 x 30 to 21 x 38 mm: 3000 hours	$U_R \leq$ 6.3 V; ΔC/C: + 15/- 30 % $U_R >$ 6.3 V; ΔC/C: ± 15 % tan $\delta \leq$ 1.3 x spec. limit Z ≤ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; Case Ø D x L = 6.5 x 18 to 10 x 25 mm: 4000 hours; case Ø D x L = 10 x 30 to 21 x 38 mm: 8000 hours	$U_R \leq$ 6.3 V; ΔC/C: + 45/- 50 % $U_R >$ 6.3 V; ΔC/C: ± 45 % tan $\delta \leq$ 3 x spec. limit Z ≤ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 % (200 V ≤ 3 %)
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; U_R = 6.3 to 63 V: 500 hours; U_R = 100 and 200 V: 100 hours After test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq$ 2 x spec. limit
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	T_{amb} = 125 °C: 125 hours at U = - 1 V followed by 125 hours at U_R	ΔC/C: ± 20 % tan $\delta \leq$ spec. limit $I_{L5} \leq$ spec. limit

Aluminum Capacitors
Axial High Temperature, DIN-Based

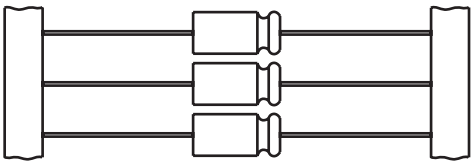
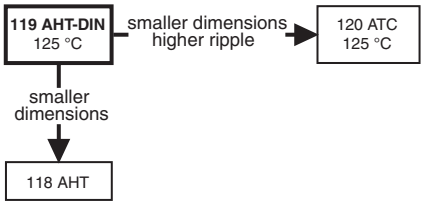


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Extra long useful life: up to 8000 hours at 125 °C, high stability, high reliability
- Extended temperature range: 125 °C (usable up to 150 °C)
- High ripple current capability
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

- Military, industrial control, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling
- For use where low mounting height is important; vibration and shock resistant

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for - 10 to + 50 %)
- Rated voltage (in V) at 125 °C and 85 °C
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number (119)

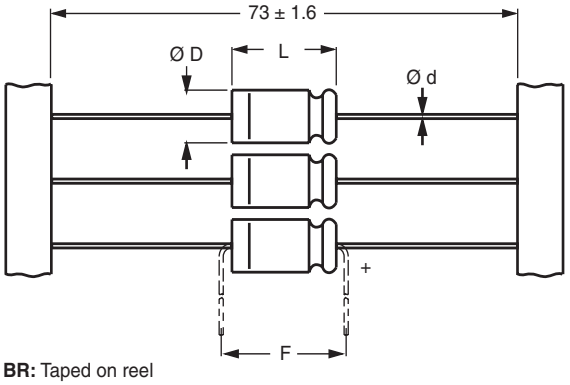
QUICK REFERENCE DATA		
DESCRIPTION	**VALUE**	
Nominal case sizes (Ø D x L in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	4.7 to 4700 µF	
Tolerance on C_R	- 10/+ 50 %	
Rated voltage range, U_R	10 to 200 V	
Category temperature range	- 55 to + 125 °C	
Endurance test at 150 °C	500 hours	500 hours
Endurance test at 125 °C	2000 hours	4000 hours
Useful life at 125 °C	4000 hours	8000 hours
Useful life at 40 °C, 1.8 x I_R applied	500 000 hours	1 000 000 hours
Shelf life at 0 V, 125 °C: U_R = 10 to 63 V U_R = 100 and 200 V	500 hours 100 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	55/125/56	

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)						
	10	**16**	**25**	**40**	**63**	**100**	**200**
4.7	-	-	-	-	-	6.5 x 18	10 x 18
10	-	-	-	-	6.5 x 18	8 x 18	10 x 25
22	-	-	6.5 x 18	-	8 x 18	10 x 18	-
47	-	6.5 x 18	-	8 x 18	10 x 18	10 x 25	-
	-	-	-	-	-	10 x 30	-
68	-	-	-	-	10 x 30	12.5 x 30	-
100	6.5 x 18	8 x 18	10 x 18	10 x 25	10 x 30	15 x 30	-
150	-	-	-	12.5 x 30	15 x 30	15 x 30	-

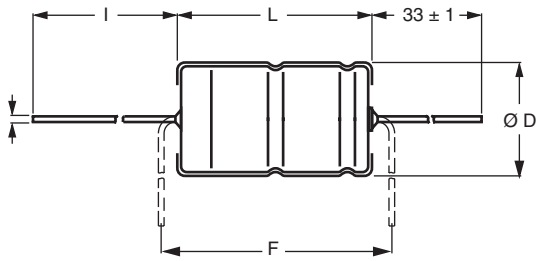
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
C_R (µF)	**U_R (V)**						
	10	**16**	**25**	**40**	**63**	**100**	**200**
220	10 x 18	10 x 25	10 x 25	12.5 x 30	15 x 30	18 x 30	-
	-	-	12.5 x 30	-	-	-	-
330	-	12.5 x 30	12.5 x 30	15 x 30	18 x 30	18 x 38	-
470	10 x 25	12.5 x 30	12.5 x 30	15 x 30	18 x 38	21 x 38	-
	12.5 x 30	-	-	-	-	-	-
680	12.5 x 30	15 x 30	18 x 30	18 x 30	21 x 38	-	-
1000	15 x 30	15 x 30	18 x 30	18 x 38	21 x 38	-	-
1500	18 x 30	18 x 30	18 x 38	21 x 38	-	-	-
2200	18 x 30	18 x 38	21 x 38	21 x 38	-	-	-
3300	18 x 38	21 x 38	-	-	-	-	-
4700	21 x 38	21 x 38	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm
Form BA: Taped in box (ammopack)
case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.3 **Forms BA and BR**



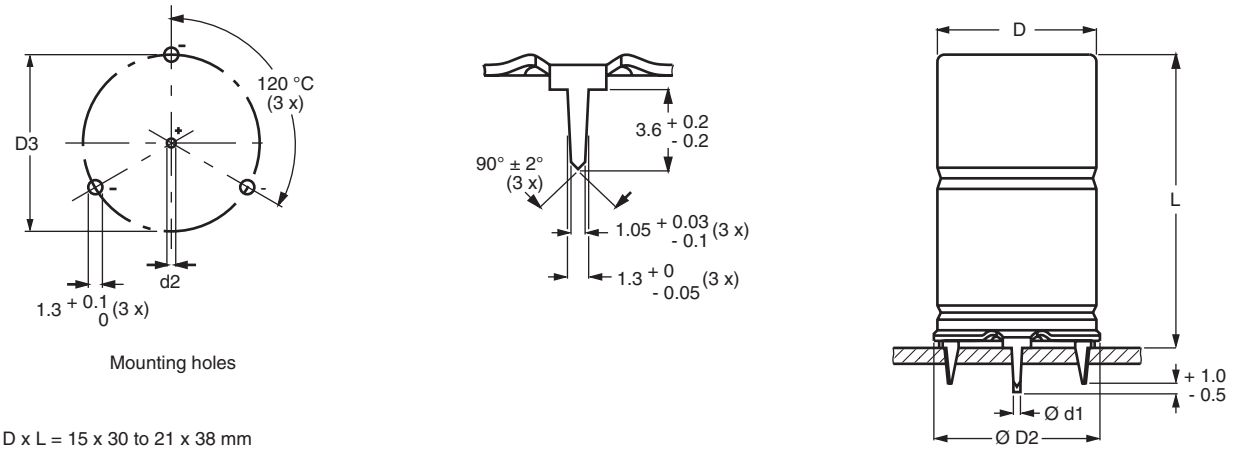
Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

Fig.3 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**										
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**AXIAL FORM AA, BA, and BR**					**MASS (g)**	**PACKAGING QUANTITIES**		
		Ø d	**l**	**Ø $D_{max.}$**	**$L_{max.}$**	**$F_{min.}$**		**FORM AA**	**FORM BA**	**FORM BR**
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note
Detailed tape dimensions see section 'PACKAGING'.



Case Ø D x L = 15 x 30 to 21 x 38 mm
Case not insulated (insulation on request)
Especially for applications with severe shocks and vibrations

Fig.4 Mounting hole digram and outline; **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**MOUNTING RING: FORM MR**						**MASS (g)**	**PACKAGING QUANTITIES**
		Ø d1	**Ø d2**	**Ø $D_{max.}$**	**Ø. $D2_{max}$**	**D3**	**$L_{max.}$**		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 8.6	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 11.5	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 14.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 19.2	100

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance - 10/+ 50 %
I_R	rated RMS ripple current at 100 Hz, 125 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 119 series

470 µF/16 V; - 10/+ 50 %

Nominal case size: Ø 12.5 x 30 mm; Form BR

Ordering code: MAL211925471E3
Former 12NC: 2222 119 25471

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2119.....			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	100	6.5 x 18	4	130	10	6	0.2	3.5	2.2	-	24101E3	34101E3	-
	220	10 x 18	6	240	17	8.4	0.18	1.3	1.0	-	24221E3	34221E3	-
	470	10 x 25	7	380	32	13	0.18	0.61	0.49	-	90501E3	90502E3	-
	470	12.5 x 30	01	550	32	13	0.16	0.54	0.38	14471E3	24471E3	-	-
	680	12.5 x 30	01	640	45	18	0.20	0.47	0.38	14681E3	24681E3	-	-
	1000	15 x 30	02	830	64	24	0.20	0.32	0.24	90032E3	24102E3	-	44102E3
	1500	18 x 30	03	1100	94	34	0.22	0.23	0.17	14152E3	-	-	44152E3
	2200	18 x 30	03	1190	136	48	0.26	0.19	0.17	14222E3	-	-	44222E3
	3300	18 x 38	04	1550	202	70	0.27	0.13	0.10	14332E3	-	-	44332E3
	4700	21 x 38	05	1700	286	90	0.30	0.10	0.09	14472E3	-	-	44472E3
16	47	6.5 x 18	4	110	10	5.5	0.13	4.4	2.2	-	25479E3	35479E3	-
	100	8 x 18	5	170	14	7.2	0.13	2.1	1.3	-	25101E3	35101E3	-
	220	10 x 25	7	300	25	11	0.13	0.94	0.55	-	25221E3	35221E3	-
	330	12.5 x 30	01	560	36	15	0.13	0.63	0.38	15331E3	25331E3	-	-
	470	12.5 x 30	01	570	50	19	0.15	0.51	0.38	15471E3	25471E3	-	-
	680	15 x 30	02	750	69	26	0.15	0.35	0.24	15681E3	25681E3	-	45681E3
	1000	15 x 30	02	850	100	36	0.19	0.30	0.24	15102E3	25102E3	-	45102E3
	1500	18 x 30	03	1120	148	52	0.20	0.21	0.17	15152E3	-	-	45152E3
	2200	18 x 38	04	1440	215	74	0.20	0.14	0.10	15222E3	-	-	45222E3
	3300	21 x 38	05	1650	321	110	0.22	0.11	0.09	15332E3	-	-	45332E3
	4700	21 x 38	05	1710	455	154	0.28	0.09	0.09	15472E3	-	-	45472E3
25	22	6.5 x 18	4	85	10	5.1	0.10	7.2	3.2	-	26229E3	36229E3	-
	100	10 x 18	6	210	19	9	0.10	1.6	1.0	-	26101E3	36101E3	-
	220	10 x 25	7	350	37	15	0.10	0.72	0.58	-	90503E3	90504E3	-
	220	12.5 x 30	01	500	37	15	0.09	0.65	0.38	16221E3	26221E3	-	-
	330	12.5 x 30	01	580	54	21	0.11	0.53	0.38	16331E3	26331E3	-	-
	470	12.5 x 30	01	630	75	28	0.13	0.44	0.38	16471E3	26471E3	-	-
	680	18 x 30	03	990	106	38	0.13	0.30	0.17	16681E3	-	-	46681E3
	1000	18 x 30	03	1090	154	54	0.13	0.21	0.17	16102E3	-	-	46102E3
	1500	18 x 38	04	1420	229	79	0.13	0.14	0.10	16152E3	-	-	46152E3
	2200	21 x 38	05	1550	334	114	0.13	0.11	0.09	16222E3	-	-	46222E3
40	47	8 x 18	5	150	15	7.8	0.08	2.7	1.5	-	27479E3	37479E3	-
	100	10 x 25	7	260	28	12	0.08	1.3	0.7	-	27101E3	37101E3	-
	150	12.5 x 30	01	440	40	16	0.08	0.85	0.51	17151E3	27151E3	-	-
	220	12.5 x 30	01	500	57	22	0.09	0.65	0.48	17221E3	27221E3	-	-
	330	15 x 30	02	630	83	30	0.09	0.43	0.37	17331E3	27331E3	-	47331E3
	470	15 x 30	02	720	117	42	0.12	0.41	0.37	17471E3	27471E3	-	47471E3
	680	18 x 30	03	970	167	58	0.12	0.28	0.22	17681E3	-	-	47681E3
	1000	18 x 38	04	1250	244	84	0.12	0.19	0.14	17102E3	-	-	47102E3
	1500	21 x 38	05	1410	364	124	0.14	0.15	0.12	17152E3	-	-	47152E3
	2200	21 x 38	05	1550	532	180	0.18	0.13	0.11	17222E3	-	-	47222E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2119.....			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	10	6.5 x 18	4	68	20	5.3	0.07	11	5.6	-	28109E3	38109E3	-
	22	8 x 18	5	110	20	6.7	0.07	5.1	2.8	-	28229E3	38229E3	-
	47	10 x 18	6	180	22	9.9	0.07	2.4	1.3	-	28479E3	38479E3	-
	68	10 x 25	7	230	30	13	0.07	1.6	1.0	-	90505E3	90506E3	-
	68	10 x 30	00	300	30	13	0.07	1.6	0.92	18689E3	28689E3	-	-
	100	10 x 30	00	360	42	17	0.08	1.3	0.75	18101E3	28101E3	-	-
	150	15 x 30	02	560	61	23	0.08	0.85	0.37	18151E3	28151E3	-	48151E3
	220	15 x 30	02	640	87	32	0.08	0.58	0.37	18221E3	28221E3	-	48221E3
	330	18 x 30	03	880	129	46	0.09	0.43	0.23	18331E3	-	-	48331E3
	470	18 x 38	04	1130	182	63	0.09	0.30	0.15	18471E3	-	-	48471E3
	680	21 x 38	05	1290	261	90	0.09	0.21	0.12	18681E3	-	-	48681E3
	1000	21 x 38	05	1430	382	130	0.10	0.16	0.11	18102E3	-	-	48102E3
100	4.7	6.5 x 18	4	44	20	10	0.08	27	10	-	29478E3	39478E3	-
	10	8 x 18	5	70	20	10	0.08	13	6.0	-	29109E3	39109E3	-
	22	10 x 18	6	112	20	10	0.08	5.8	3.5	-	29229E3	39229E3	-
	47	10 x 25	7	178	32	13	0.08	2.7	2.0	-	90518E3	90519E3	-
	47	10 x 30	00	240	32	13	0.08	2.7	2.0	19479E3	29479E3	-	-
	68	12.5 x 30	01	330	45	18	0.08	1.9	1.2	19689E3	29689E3	-	-
	100	15 x 30	02	440	64	24	0.09	1.4	0.96	19101E3	29101E3	-	49101E3
	150	15 x 30	02	520	94	34	0.10	1.1	0.78	19151E3	29151E3	-	49151E3
	220	18 x 30	03	710	136	48	0.10	0.72	0.55	19221E3	-	-	49221E3
	330	18 x 38	04	920	202	70	0.10	0.48	0.37	19331E3	-	-	49331E3
	470	21 x 38	05	1070	286	98	0.10	0.34	0.28	19471E3	-	-	49471E3
200	4.7	10 x 18	6	52	20	10	0.08	27	10	-	90507E3	90508E3	-
	10	10 x 25	7	82	20	10	0.08	13	5.0	-	90509E3	90511E3	-

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	After 1 minute:		
	U_R = 10 to 40 V	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA, or 10 µA (whichever is greater)	
	U_R = 63 V to 200 V	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA, or 20 µA (whichever is greater)	
	After 5 minutes:		
	U_R = 10 to 63 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA	
	U_R = 100 and 200 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA, or 10 µA (whichever is greater)	
Inductance			

ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Equivalent series inductance (ESL)	Case Ø D x L mm:		
	6.5 x 18	typ. 15 nH	-
	8 x 18	typ. 35 nH	-
	10 x 18	typ. 69 nH	-
	10 x 25	typ. 38 nH	-
	10 x 30	typ. 38 nH	-
	12.5 x 30	typ. 46 nH	-
	15 x 30	typ. 48 nH	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

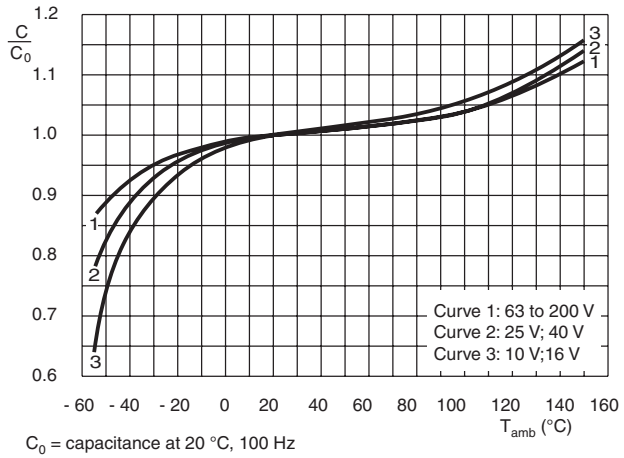
Table 4

UPRATING VALUES AT REDUCED AMBIENT TEMPERATURE									
SYMBOL	CONDITIONS	VALUES							UNIT
U_R	T_{amb} > 85 to 125 °C	10	16	25	40	63	100	200	V
U_{R2}	$T_{amb} \leq 85$ °C	16	25	40	63	100	125	250	V

Note

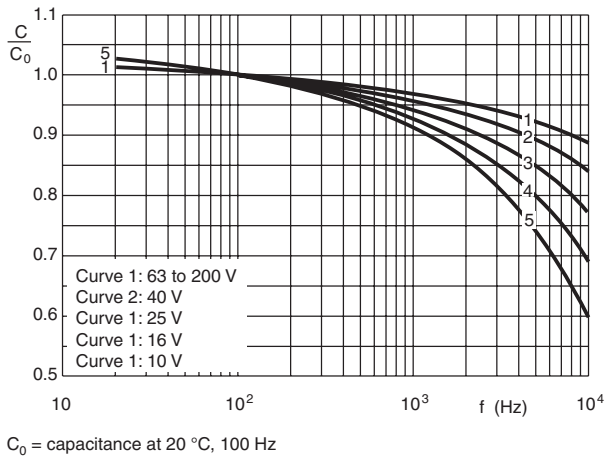
For applications at ambient temperatures of ≤ 85 °C, the rated voltage (U_R) may be raised to U_{R2}.

CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100 Hz

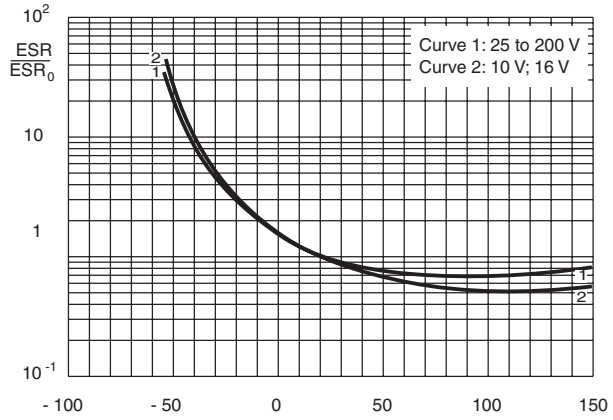
Fig.5 Typical multiplier of capacitance as a function of ambient temperature



C_0 = capacitance at 20 °C, 100 Hz

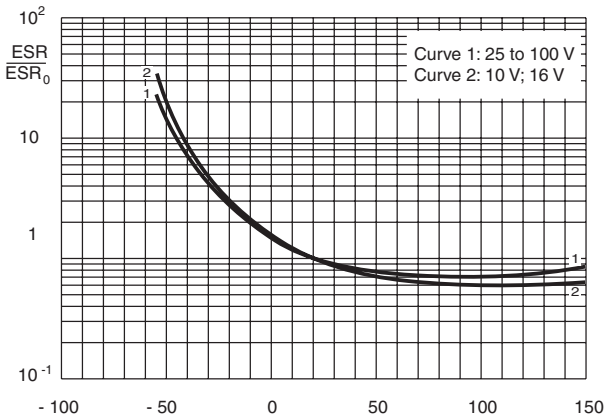
Fig.6 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)



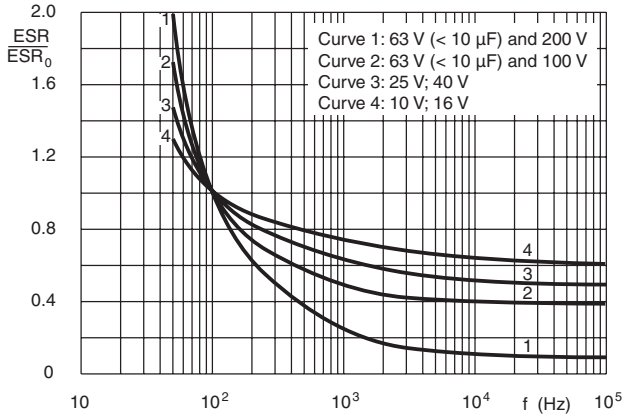
Case Ø D x L = 6.5 x 18 to 15 x 30 mm
ESR_0 = typical at 20 °C, 100 Hz

Fig.7 Typical multiplier of ESR as a function of ambient temperature



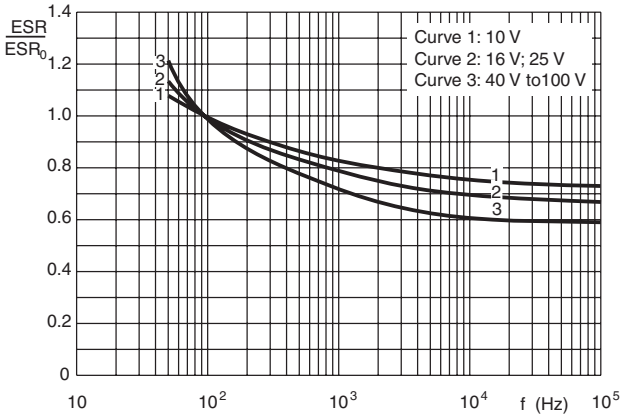
Case Ø D x L = 18 x 30 to 21 x 38 mm
ESR_0 = typical at 20 °C, 100 Hz

Fig.8 Typical multiplier of ESR as a function of ambient temperature



Case Ø D x L = 6.5 x 18 to 10 x 25 mm
ESR_0 = typical at 20 °C, 100 Hz

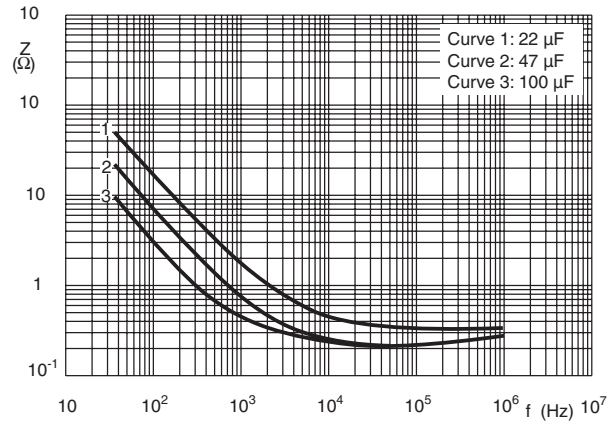
Fig.9 Typical multiplier of ESR as a function of frequency



Case Ø D x L = 10 x 30 to 21 x 38 mm
ESR_0 = typical at 20 °C, 100 Hz

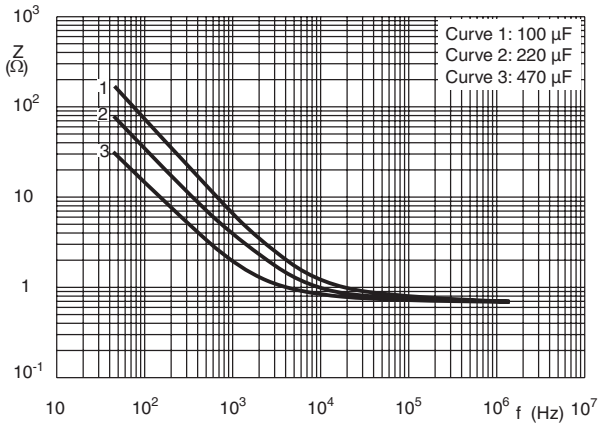
Fig.10 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)



Case Ø D x L = 8 x 18 mm

Fig.11 Typical impedance as a function of frequency



Case Ø D x L = 8 x 18 mm

T_{amb} (°C)

Fig.12 Typical impedance as a function of frequency

IMPEDANCE (Z)

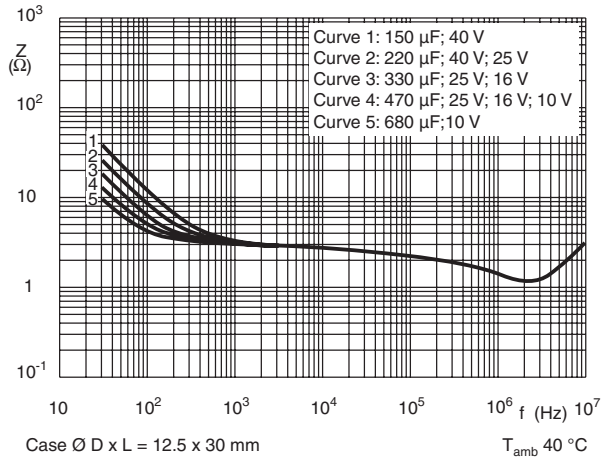


Fig.13 Typical impedance as a function of frequency

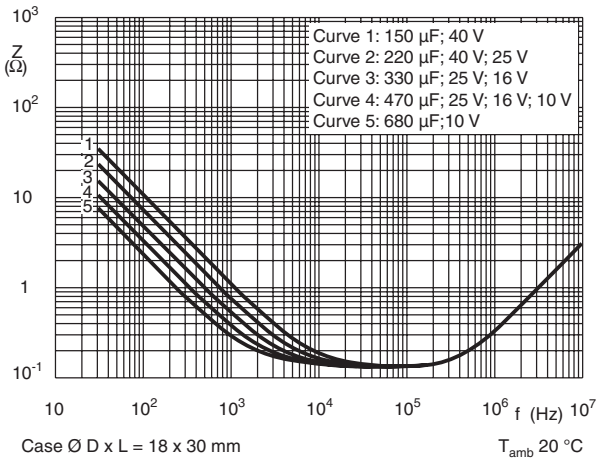


Fig.14 Typical impedance as a function of frequency

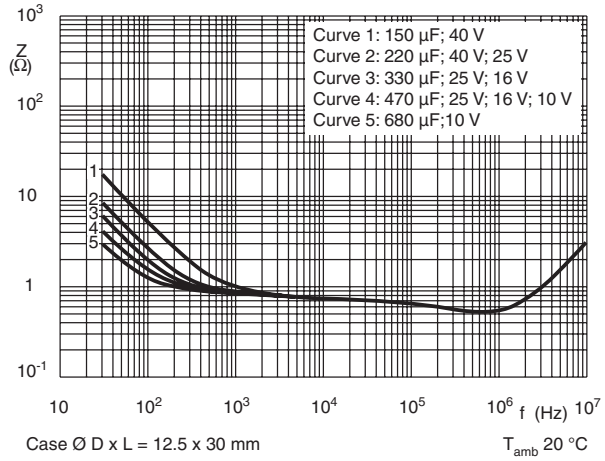


Fig.15 Typical impedance as a function of frequency

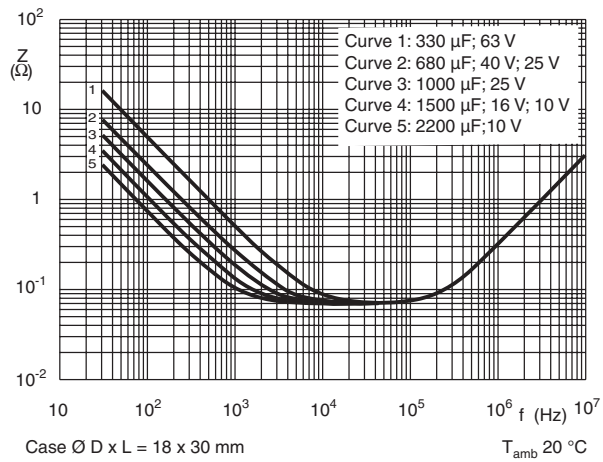
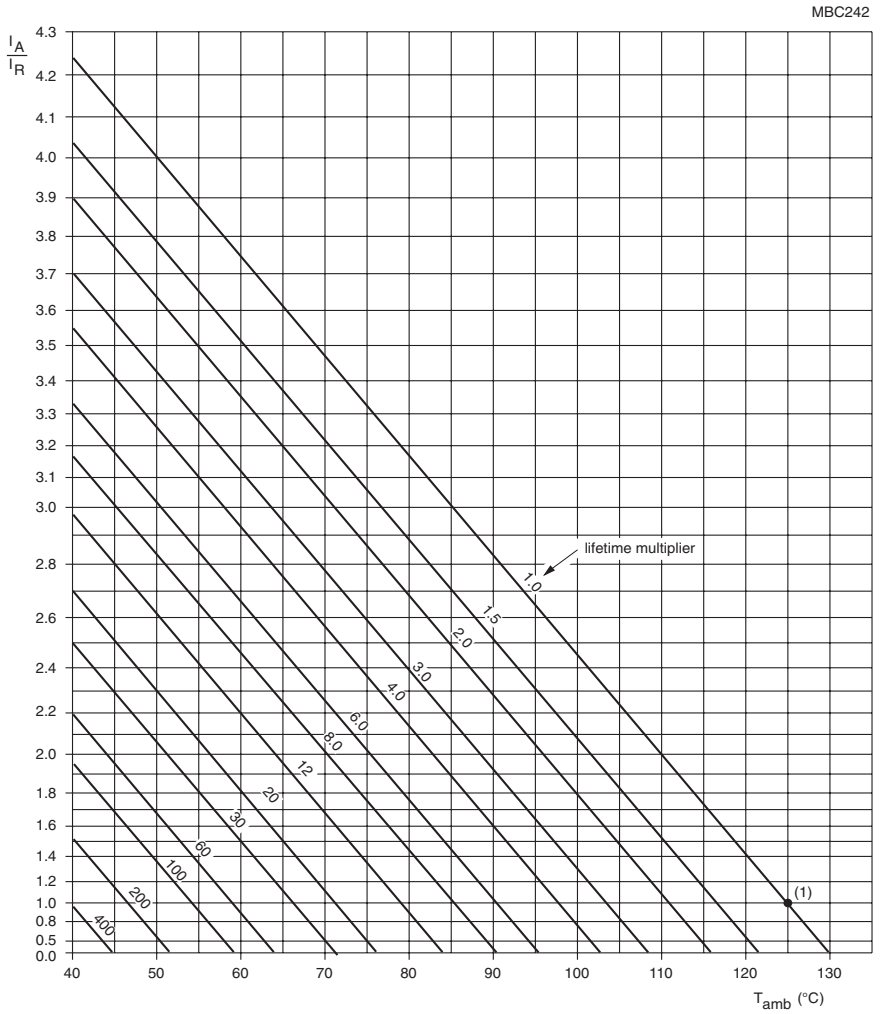


Fig.16 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 125 °C
(1) Useful life at 125 °C and I_R applied:
case ∅ D x L = 6.5 x 18 to 10 x 25 mm: 4000 hours
case ∅ D x L = 10 x 30 to 21 x 38 mm: 8000 hours

Fig.17 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 and 16 V	U_R = 25 and 40 V	U_R = 63 to 200 V
50	0.95	0.90	0.85
100	1.00	1.00	1.00
300	1.07	1.12	1.20
1000	1.12	1.20	1.30
3000	1.15	1.25	1.35
≥ 10 000	1.20	1.30	1.40

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R applied; Case Ø D x L = 6.5 x 18 to 10 x 25 mm: 2000 hours; Case Ø D x L = 10 x 30 to 21 x 38 mm: 4000 hours	$\Delta C/C$: ± 15 % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; Case Ø D x L = 6.5 x 18 to 10 x 25 mm: 4000 hours; Case Ø D x L = 10 x 30 to 21 x 38 mm: 8000 hours	$\Delta C/C$: ± 45 % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 % (200 V ≤ 3 %)
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; U_R = 10 to 63 V: 500 hours; U_R = 100 and 200 V: 100 hours After test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq$ 2 x spec. limit
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	T_{amb} = 125 °C: 125 hours at U = - 1 V followed by 125 hours at U_R	$\Delta C/C$: ± 20 % tan $\delta \leq$ spec. limit $I_{L5} \leq$ spec. limit

Aluminum Capacitors
Axial High Temperature, High Ripple Current

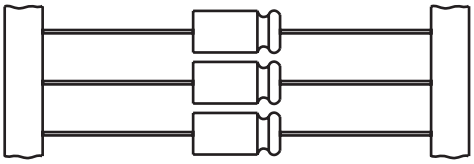
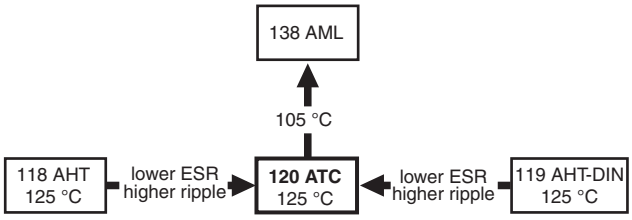


Fig.1 Component outlines



QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	10 x 30 to 21 x 38
Rated capacitance range, C_R	47 to 6800 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	16 to 100 V
Category temperature range	- 40 to + 125 °C
Endurance test at 150 °C	1000 hours
Endurance test at 125 °C	4000 hours
Useful life at 125 °C	8000 hours
Useful life at 85 °C, 1.4 x I_R applied	40 000 hours
Shelf life at 0 V, 125 °C	1000 hours (100 V: 500 hours)
Shelf life at 0 V, 150 °C	≤ 63 V: 500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/125/56

FEATURES

Pb-free

RoHS COMPLIANT

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Extra long useful life: up to 8000 hours at 125 °C, high reliability
- Lowest ESR levels providing very high ripple current capability
- Extended temperature range: usable up to 150 °C
- Miniaturized, high CV-product per unit volume
- Lead diameter Ø d = 1.0 mm, available on request
- Lead (Pb)-free versions are RoHS compliant

APPLICATIONS

- Automotive, industrial and telecommunication
- Smoothing, filtering, buffering
- Low mounting height applications, vibration and shock resistant
- SMPS and standard power supplies

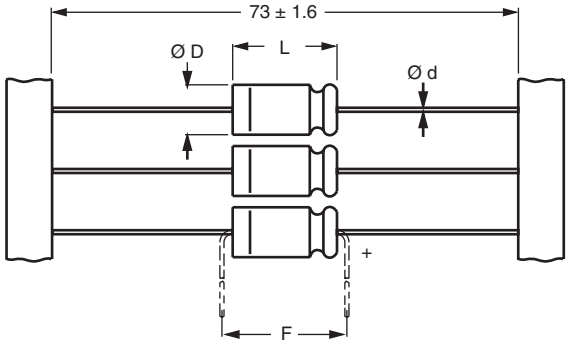
MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (125 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number (120)

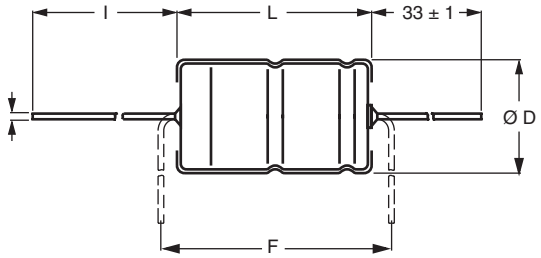
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZE (Ø D x L in mm)					
C_R (µF)	**U_R (V)**				
	16	**25**	**40**	**63**	**100**
47	-	-	-	-	10 x 30
68	-	-	-	-	12.5 x 30
100	-	-	-	10 x 30	12.5 x 30
150	-	-	-	12.5 x 30	15 x 30
220	-	-	10 x 30	12.5 x 30	18 x 30
330	-	-	12.5 x 30	15 x 30	18 x 38
470	-	10 x 30	12.5 x 30	18 x 30	21 x 38
680	10 x 30	12.5 x 30	15 x 30	18 x 38	-
1000	12.5 x 30	12.5 x 30	18 x 30	21 x 38	-
1500	12.5 x 30	15 x 30	18 x 38	-	-
2200	15 x 30	18 x 30	21 x 38	-	-
3300	18 x 30	18 x 38	-	-	-
4700	18 x 38	21 x 38	-	-	-
6800	21 x 38	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



Form BR: Taped on reel, non-preferred
case Ø D x L = 10 x 30 to 15 x 30 mm

Fig.2 **Form BR**



Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

Fig.3 **Form AA**

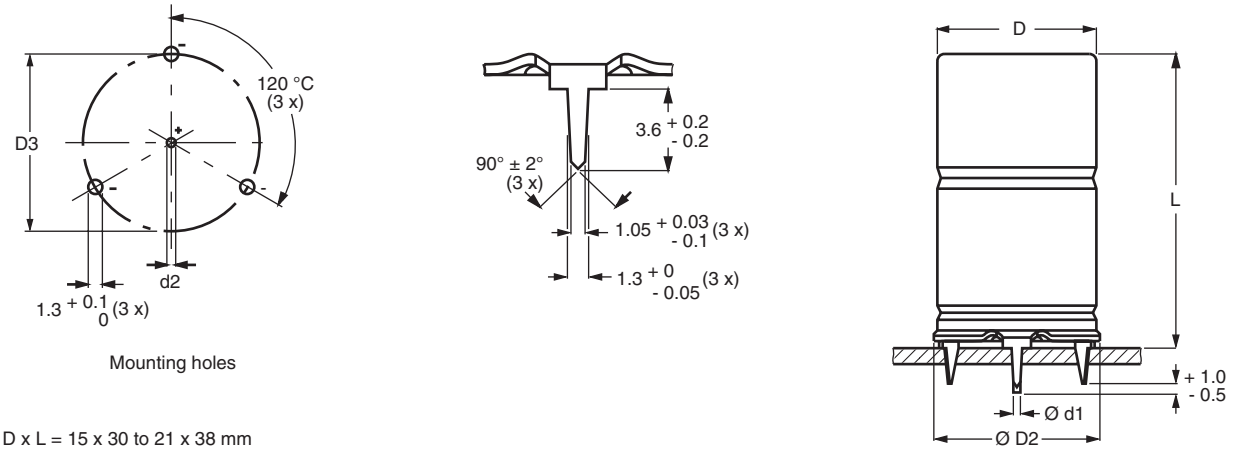
Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE Ø D x L (mm)	**AXIAL: FORM AA AND BR**					**MASS (g)**	**PACKAGING QUANTITIES**	
	Ø d (1)	**l**	**Ø $D_{max.}$**	**$L_{max.}$**	**$F_{min.}$**		**FORM AA**	**FORM BR**
10 x 30	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	500
12.5 x 30	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	400
15 x 30	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	250
18 x 30	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-
18 x 38	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-
21 x 38	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-

Note

(1) Lead diameter Ø d = 1.0 mm, available on request.

Detailed tape dimensions see section 'PACKAGING'.



Case Ø D x L = 15 x 30 to 21 x 38 mm

Case not insulated (insulation on request)

Especially for applications with severe shocks and vibrations

Fig.5 Mounting hole digram and outline; **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**MOUNTING RING: FORM MR**						**MASS (g)**	**PACKAGING QUANTITIES**
		Ø d1	**Ø d2**	**Ø $D_{max.}$**	**Ø $D2_{max.}$**	**D3**	**$L_{max.}$**		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 8.6	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 11.5	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 14.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 19.2	100

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 10 kHz, 125 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 120 series

1000 µF/16 V; ± 20 %

Nominal case size: Ø 12.5 x 30 mm; Form BR

Ordering code: MAL212025102E3

Former 12NC: 2222 120 25102

Table 3

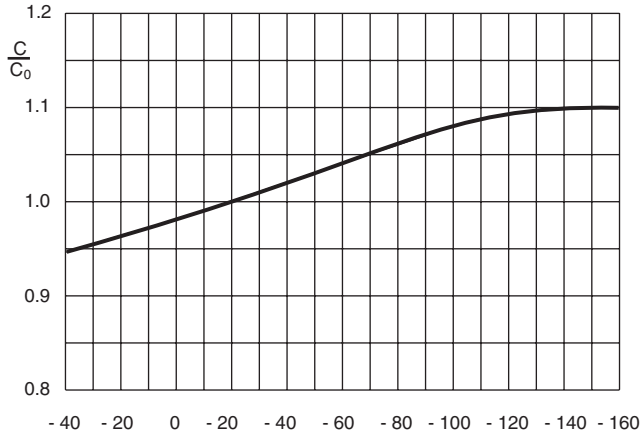
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 10 kHz 125 °C (mA)	I_{L1} 1 MIN (µA)	I_{L5} 5 MIN (µA)	TYP. ESR 100 Hz (mΩ)	MAX. ESR 100 Hz (mΩ)	TYP. ESR 10 kHz (mΩ)	MAX. ESR 10 kHz (mΩ)	Z MAX. 10 kHz (mΩ)	ORDERING CODE MAL2120.....		
											IN BOX FORM AA	TAPED ON REEL FORM BR	MOUNTING RING FORM MR
	680	10 x 30	2100	171	84	106	177	44	74	78	15681E3	25681E3	-
	1000	12.5 x 30	2550	232	104	77	128	35	58	61	15102E3	25102E3	-
	1500	12.5 x 30	2650	328	136	60	100	32	53	53	15152E3	25152E3	-
16	2200	15 x 30	2940	462	181	48	79	28	46	46	15222E3	25222E3	45222E3
	3300	18 x 30	3430	674	251	41	68	26	43	43	15332E3	-	45332E3
	4700	18 x 38	4350	942	341	27	45	18	29	29	15472E3	-	45472E3
	6800	21 x 38	4590	1346	475	26	43	18	29	29	15682E3	-	45682E3
	470	10 x 30	2100	181	87	112	187	45	74	84	16471E3	26471E3	-
	680	12.5 x 30	2550	244	108	81	136	35	59	64	16681E3	26681E3	-
	1000	12.5 x 30	2600	340	140	64	107	32	53	55	16102E3	26102E3	-
25	1500	15 x 30	2890	490	190	49	82	28	46	46	16152E3	26152E3	46152E3
	2200	18 x 30	3310	700	260	43	71	27	44	44	16222E3	-	46222E3
	3300	18 x 38	4350	1030	370	28	47	18	29	29	16332E3	-	46332E3
	4700	21 x 38	4470	1450	510	27	44	18	29	29	16472E3	-	46472E3
	220	10 x 30	1990	146	75	192	320	52	87	124	17221E3	27221E3	-
	330	12.5 x 30	2430	198	93	130	216	37	62	83	17331E3	27331E3	-
	470	12.5 x 30	2550	266	115	101	169	35	58	70	17471E3	27471E3	-
40	680	15 x 30	2840	366	149	75	125	30	50	55	17681E3	27681E3	47681E3
	1000	18 x 30	3150	520	200	59	99	28	47	49	17102E3	-	47102E3
	1500	18 x 38	4130	760	280	39	65	19	31	32	17152E3	-	47152E3
	2200	21 x 38	4170	1096	392	34	56	19	31	31	17222E3	-	47222E3
	100	10 x 30	1560	116	65	297	495	92	154	249	18101E3	28101E3	-
	150	12.5 x 30	2050	153	78	195	325	61	102	162	18151E3	28151E3	-
	220	12.5 x 30	2150	206	95	149	249	55	92	126	18221E3	28221E3	-
63	330	15 x 30	2510	289	123	105	175	44	73	91	18331E3	28331E3	48331E3
	470	18 x 30	2860	395	158	81	135	38	64	74	18471E3	-	48471E3
	680	18 x 38	3720	554	211	55	92	26	43	49	18681E3	-	48681E3
	1000	21 x 38	3780	796	292	44	74	25	41	43	18102E3	-	48102E3
	47	10 x 30	760	96	59	760	1269	349	581	720	19479E3	29479E3	-
	68	12.5 x 30	1030	122	67	531	885	246	410	503	19689E3	29689E3	-
	100	12.5 x 30	1140	160	80	389	648	196	327	381	19101E3	29101E3	-
100	150	15 x 30	1480	220	100	266	443	137	229	262	19151E3	29151E3	49151E3
	220	18 x 30	1960	304	128	181	302	95	158	179	19221E3	-	49221E3
	330	18 x 38	2550	436	172	120	200	62	104	117	19331E3	-	49331E3
	470	21 x 38	2800	604	228	92	154	52	86	94	19471E3	-	49471E3

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.012\ C_R \times U_R + 40\ \mu A$	
	After 5 minutes at U_R	$I_{L5} \leq 0.004\ C_R \times U_R + 40\ \mu A$	
Inductance			
Equivalent series inductance (ESL)	Case Ø D x L mm:		
	10 x 30	typ. 38 nH	
	12.5 x 30	typ. 46 nH	
	15 x 30	typ. 48 nH	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

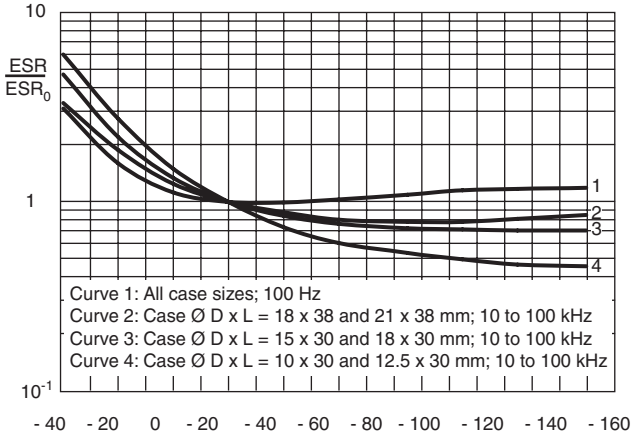
CAPACITANCE (C)



All voltages; all case sizes
C_0 = capacitance at 20 °C, 100 Hz

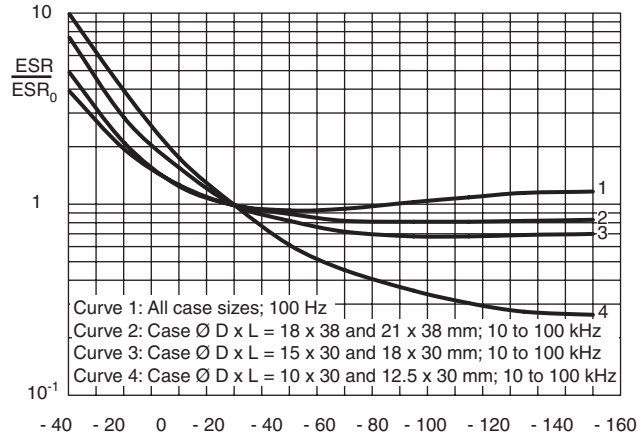
Fig.5 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)



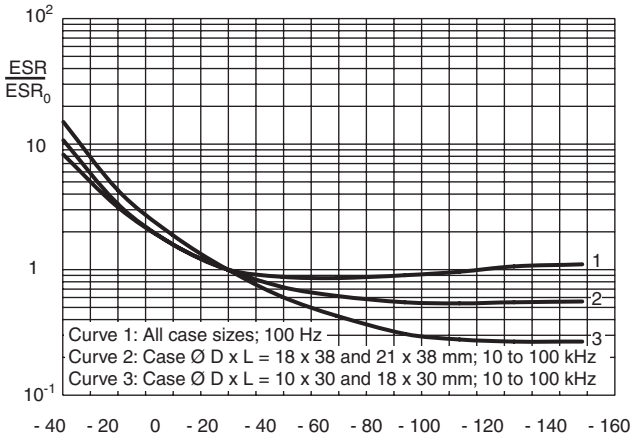
≤ 40 V types
ESR_0 = typical at 20 °C

Fig.6 Typical multiplier of ESR as a function of ambient temperature at different frequencies



63 V types
ESR_0 = typical at 20 °C

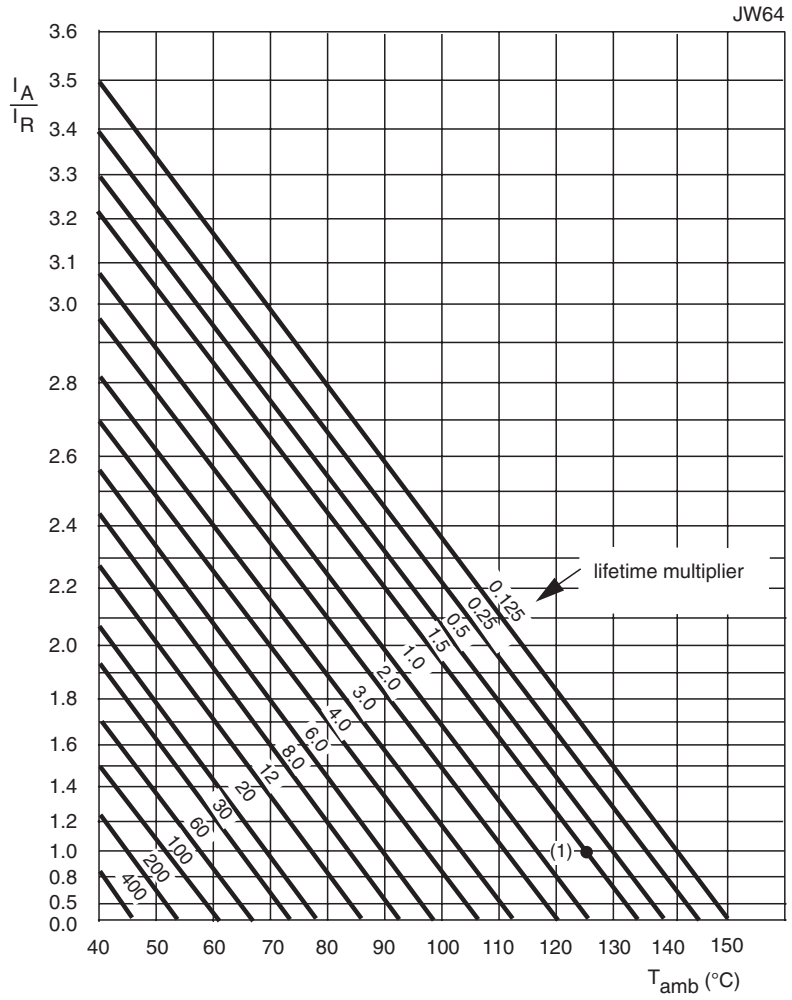
Fig.7 Typical multiplier of ESR as a function of ambient temperature at different frequencies



100 V types
ESR_0 = typical at 20 °C

Fig.8 Typical multiplier of ESR as a function of ambient temperature at different frequencies

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 10 kHz

I_R = rated ripple current at 10 kHz, 125 °C

(1) Useful life at 125 °C and IR applied: 8000 hours

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY				
FREQUENCY (Hz)	I_R MULTIPLIER			
	U_R = 16 to 40 V CASE SIZES 10 x 30 to 15 x 30 mm	U_R = 16 to 40 V CASE SIZES 18 x 30 to 21 x 38 mm	U_R = 63 and 100 V CASE SIZES 10 x 30 to 15 x 30 mm	U_R = 63 and 100 V CASE SIZES 18 x 30 to 21 x 38 mm
50	0.37	0.54	0.23	0.44
100	0.48	0.63	0.32	0.56
300	0.69	0.75	0.53	0.76
1000	0.86	0.81	0.77	0.88
3000	0.96	0.87	0.93	0.94
≥ 10 000	1.00	1.00	1.00	1.00

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (QUICK REFERENCE)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R applied; 4000 hours T_{amb} = 150 °C; U_R applied; 1000 hours	$\Delta C/C$: ± 15 % tan $\delta \leq$ 1.3 x spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; 8000 hours	$\Delta C/C$: ± 45 % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; 1000 hours (100 V: 500 hours) T_{amb} = 150 °C; no voltage applied; 500 hours for voltages: ≤ 63 V after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq 2$ x spec. limit
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	T_{amb} = 125 °C: 125 hours at U = - 1 V followed by 125 hours at U_R	$\Delta C/C$: ± 20 % tan $\delta \leq$ spec. limit $I_{L5} \leq$ spec. limit

Aluminum Capacitors
Solid Axial

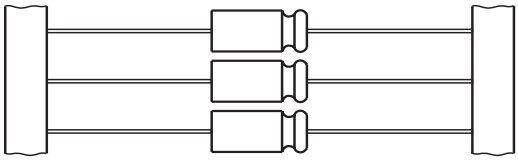
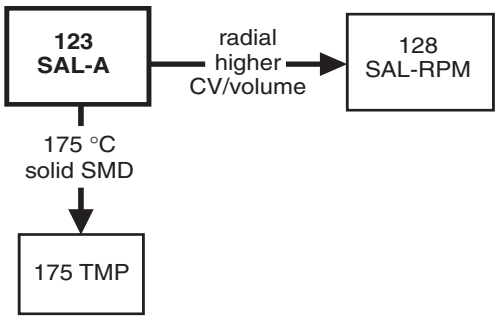


Fig.1 Component outline



QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Maximum case size (Ø D x L in mm)	6.7 x 15.3 to 12.9 x 32.0
Rated capacitance range (E6 series), C_R	1.0 µF to 1500 µF
Tolerance on C_R	± 20 %; ± 10 % on request
Rated voltage range, U_R	6.3 V to 40 V
Category temperature range	- 55 °C to + 125 °C
Usable temperature range	- 80 °C to + 200 °C
Endurance test at 155 °C and 125 °C	5000 hours and 8000 hours
Useful life at 125 °C	20 000 hours
Useful life at 40 °C, I_R applied	450 000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/125/56

FEATURES

Pb-free Available

RoHS* COMPLIANT

- Polarized aluminum electrolytic capacitors, solid electrolyte MnO_2
- Axial leads, aluminum case, ceramic seal, blue insulation sleeve
- SAL-A: standard version
- SAL-AG: epoxy filled shock-proof version up to 10 000 g
- Extremely long useful life: 20 000 hours at 125 °C
- Extended high temperature range up to 200 °C
- Excellent low temperature impedance and ESR behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.3 x U_R allowed
- AC voltage up to 0.8 x U_R allowed
- Advanced technology to achieve high reliability and high stability

APPLICATIONS

- EDP, telecommunication, industrial high temperature, automotive, military and space
- Smoothing, filtering, buffering, timing
- For power supplies, DC/DC converters

MARKING

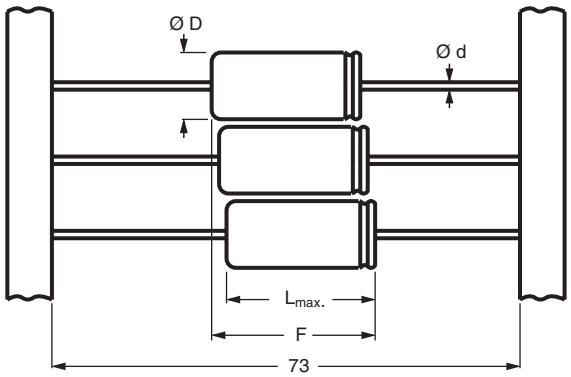
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M = ± 20 %, K = ± 10 %)
- Rated voltage (in V) at corresponding maximum temperature
- Date code in accordance with IEC 60062
- Name of manufacturer
- Code for factory of origin
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal
- Series number

* Pb containing terminations are not RoHS compliant, exemptions may apply

SELECTION CHART FOR C_R, U_R AND RELEVANT MAXIMUM CASE SIZES (Ø D x L in mm)						
C_R (µF)	U_R (V) at T_{amb} = 85 °C					
	6.3	10	16	25	35	40
	U_C (V) at T_{amb} = 125 °C					
	6.3	10	16	25	25	25
1.0	-	-	-	-	6.7 x 15.3	-
1.5	-	-	-	-	6.7 x 15.3	-
2.2	-	-	-	-	6.7 x 15.3	6.7 x 15.3
3.3	-	-	-	-	6.7 x 15.3	6.7 x 15.3
4.7	-	-	-	-	6.7 x 15.3	6.7 x 15.3
6.8	-	-	-	-	6.7 x 15.3	6.7 x 15.3
10	-	-	6.7 x 15.3	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4
15	-	-	6.7 x 15.3	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4
22	-	-	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4	9.4 x 23.3
33	-	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4	9.4 x 23.3	9.4 x 23.3
47	6.7 x 15.3	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4	9.4 x 23.3	10.3 x 32.0
68	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4	9.4 x 23.3	10.3 x 32.0	10.3 x 32.0
100	-	7.6 x 20.4	9.4 x 23.3	9.4 x 23.3	12.9 x 32.0	12.9 x 32.0
150	7.6 x 20.4	9.4 x 23.3	9.4 x 23.3	10.3 x 32.0	12.9 x 32.0	-
220	-	9.4 x 23.3	10.3 x 32.0	12.9 x 32.0	-	-
330	9.4 x 23.3	10.3 x 32.0	10.3 x 32.0	12.9 x 32.0	-	-
470	-	10.3 x 32.0	12.9 x 32.0	-	-	-
680	10.3 x 32.0	12.9 x 32.0	12.9 x 32.0	-	-	-
1000	12.9 x 32.0	12.9 x 32.0	-	-	-	-
1500	12.9 x 32.0	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS



BA: taped in box (ammopack)
BR: taped on reel

Fig.2 Forms: **BA and BR**

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES						
CASE				MASS (2) (g)	PACKAGING QUANTITIES	
MAXIMUM SIZE Ø D x L (1)	CODE	$F_{max.}$	Ø d		FORM BA	FORM BR
6.7 x 15.3	1	20.0	0.6	≈ 1.05	100	800
7.6 x 20.4	2A	22.5	0.6	≈ 1.55	100	800
9.4 x 23.3	4	25.0	0.6	≈ 2.6	100	500
10.3 x 32.0	5	35.0	0.8	≈ 4.2	100	500
12.9 x 32.0	6	35.0	0.8	≈ 7	100	400

Notes
(1) For epoxy-filled versions add 1 mm to stated $L_{max.}$.
(2) Add 10 % for SAL-AG epoxy-filled versions.
Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz
I_R	max. RMS ripple current, no necessary DC voltage applied
I_{L5}	max. leakage current after 5 minutes at U_R
tan δ	max. dissipation factor at 100 Hz
ESR	max./typ. equivalent series resistance at 100 Hz
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 to 25 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitors 123 series

10 µF/16 V; ± 20 %
Maximum case size: Ø 6.7 x 15.3 mm; Form BR

for lead (Pb)-free:

Ordering code: MAL212325109E3
Former 12NC: 228112325109

for non lead (Pb)-free:

Ordering code: MAL212325109
Former 12NC: 222212325109

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION for 123 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAX. CASE SIZE Ø D x L (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	MAX. ESR 100 Hz (Ω)	TYP. ESR 100 Hz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2123.....E3 Lead (Pb)-free MAL2123 ..... Non lead (Pb)-free			
												SAL-A FORM BA tol. ± 20 %	SAL-A FORM BR tol. ± 20 %	SAL-AG (1) FORM BA tol. ± 10 % level S	SAL-AG (1) FORM BA tol. ± 20 %
6.3	6.3	47	6.7 x 15.3	58	440	640	15	0.18	7.6	3.0	1.2	13479	23479	83479	63479
		68	6.7 x 15.3	83	520	760	21	0.18	5.3	2.6	1.2	13689	23689	83689	63689
		150	7.6 x 20.4	160	870	1270	47	0.18	2.4	1.5	1.0	13151	23151	83151	63151
		330	9.4 x 23.3	330	1470	2140	104	0.18	1.1	0.55	0.4	13331	23331	83331	63331
		680	10.3 x 32.0	680	2340	3410	214	0.18	0.55	0.28	0.3	13681	23681	83681	63681
		1000	12.9 x 32.0	940	3180	4640	315	0.18	0.36	0.19	0.2	13102	23102	83102	63102
		1500	12.9 x 32.0	1220	4140	6020	473	0.18	0.24	0.13	0.2	13152	23152	83152	63152
10	10	33	6.7 x 15.3	63	360	530	17	0.18	11	3.8	1.2	14339	24339	84339	64339
		47	6.7 x 15.3	83	440	640	24	0.18	7.6	4.0	1.2	14479	24479	84479	64479
		68	7.6 x 20.4	110	590	850	34	0.18	5.3	2.5	1.0	14689	24689	84689	64689
		100	7.6 x 20.4	160	710	1040	50	0.18	3.6	1.8	1.0	14101	24101	84101	64101
		150	9.4 x 23.3	240	990	1450	75	0.18	2.4	0.9	0.4	14151	24151	84151	64151
		220	9.4 x 23.3	350	1180	1720	110	0.18	1.7	0.6	0.4	14221	24221	84221	64221
		330	10.3 x 32.0	490	1650	2410	165	0.18	1.1	0.45	0.3	14331	24331	84331	64331
		470	10.3 x 32.0	570	1940	2830	235	0.18	0.8	0.35	0.3	14471	24471	84471	64471
		680	12.9 x 32.0	760	2580	3750	340	0.18	0.55	0.25	0.2	14681	24681	84681	64681
		1000	12.9 x 32.0	1000	3380	4920	500	0.18	0.36	0.18	0.2	14102	24102	84102	64102
16	16	10	6.7 x 15.3	31	230	330	16	0.14	28	8.0	2.5	15109	25109	85109	65109
		15	6.7 x 15.3	47	280	400	24	0.14	19	5.5	2.5	15159	25159	85159	65159
		22	6.7 x 15.3	63	340	490	35	0.14	13	5.5	2.5	15229	25229	85229	65229
		33	7.6 x 20.4	89	470	680	55	0.14	8.4	3.0	2.0	15339	25339	85339	65339
		47	7.6 x 20.4	120	560	810	75	0.14	5.9	2.6	2.0	15479	25479	85479	65479
		68	7.6 x 20.4	180	670	970	110	0.14	4.1	2.5	2.0	15689	25689	85689	65689
		100	9.4 x 23.3	260	920	1340	160	0.14	2.8	1.5	0.8	15101	25101	85101	65101
		150	9.4 x 23.3	310	1060	1550	240	0.16	2.1	0.7	0.8	15151	25151	85151	65151
		220	10.3 x 32.0	420	1420	2060	350	0.16	1.5	0.55	0.6	15221	25221	85221	65221
		330	10.3 x 32.0	510	1740	2530	500	0.16	1.0	0.35	0.6	15331	25331	85331	65331
		470	12.9 x 32.0	680	2280	3330	750	0.16	0.7	0.25	0.4	15471	25471	85471	65471
		680	12.9 x 32.0	850	2870	4170	870	0.16	0.5	0.18	0.4	15681	25681	85681	65681
25	25	10	6.7 x 15.3	43	230	330	25	0.14	28	13.0	5	16109	26109	86109	66109
		15	6.7 x 15.3	60	280	400	35	0.14	19	10.0	5.0	16159	26159	86159	66159
		22	7.6 x 20.4	88	370	550	55	0.14	13	7	2.5	16229	26229	86229	66229
		33	7.6 x 20.4	130	470	680	85	0.14	8.4	5	2.5	16339	26339	86339	66339
		47	7.6 x 20.4	160	560	810	100	0.14	5.9	3.5	2.5	16479	26479	86479	66479
		68	9.4 x 23.3	230	760	1110	170	0.14	4.1	1.8	1.0	16689	26689	86689	66689
		100	9.4 x 23.3	250	860	1250	250	0.16	3.2	1.0	1.0	16101	26101	86101	66101
		150	10.3 x 32.0	350	1200	1740	400	0.16	2.1	1.2	0.8	16151	26151	86151	66151
		220	12.9 x 32.0	460	1560	2270	550	0.16	1.5	0.85	0.6	16221	26221	86221	66221
		330	12.9 x 32.0	600	2030	2950	800	0.16	1.0	0.60	0.6	16331	26331	86331	66331

ELECTRICAL DATA AND ORDERING INFORMATION for 123 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAX. CASE SIZE Ø D x L (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	MAX. ESR 100 Hz (Ω)	TYP. ESR 100 Hz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2123.....E3 Lead (Pb)-free MAL2123 ..... Non lead (Pb)-free			
												SAL-A FORM BA tol. ± 20 %	SAL-A FORM BR tol. ± 20 %	SAL-AG (1) FORM BA tol. ± 10 % level S	SAL-AG (1) FORM BA tol. ± 20 %
25	35	1.0	6.7 x 15.3	4	55	80	5	0.12	240	105	16.5	10108	20108	80108	60108
		1.5	6.7 x 15.3	7	68	98	5	0.12	160	40.60	11.0	10158	20158	80158	60158
		2.2	6.7 x 15.3	10	82	120	5	0.12	109	30	7.5	10228	20228	80228	60228
		3.3	6.7 x 15.3	14	100	150	7	0.12	73	28	7.5	10338	20338	80338	60338
		4.7	6.7 x 15.3	20	120	170	10	0.12	51	20	7.5	10478	20478	80478	60478
		6.8	6.7 x 15.3	27	140	210	15	0.12	35	16	7.5	10688	20688	80688	60688
		10	7.6 x 20.4	37	200	280	20	0.12	24	10	2.5	10109	20109	80109	60109
		15	7.6 x 20.4	53	240	350	30	0.12	16	8	2.5	10159	20159	80159	60159
		22	7.6 x 20.4	78	290	420	45	0.12	11	7	2.5	10229	20229	80229	60229
		33	9.4 x 23.3	120	410	590	65	0.12	7.2	3	1.0	10339	20339	80339	60339
		47	9.4 x 23.3	140	480	700	95	0.12	5.1	2.9	1.0	10479	20479	80479	60479
		68	10.3 x 32.0	170	570	820	135	0.16	4.7	2.1	0.8	10689	20689	80689	60689
		100	12.9 x 32.0	220	760	1100	200	0.16	3.2	1.7	0.6	10101	20101	80101	60101
		150	12.9 x 32.0	290	990	1440	300	0.16	2.1	1.0	0.6	10151	20151	80151	60151
25	40	2.2	6.7 x 15.3	11	82	120	9	0.12	109	38	7.5	17228	27228	87228	67228
		3.3	6.7 x 15.3	16	100	150	13	0.12	73	25	7.5	17338	27338	87338	67338
		4.7	6.7 x 15.3	22	120	170	19	0.12	51	20	7.5	17478	27478	87478	67478
		6.8	6.7 x 15.3	28	140	210	27	0.12	35	15	7.5	17688	27688	87688	67688
		10	7.6 x 20.4	41	200	280	40	0.12	24	11	2.5	17109	27109	87109	67109
		15	7.6 x 20.4	61	240	350	60	0.12	16	7	2.5	17159	27159	87159	67159
		22	9.4 x 23.3	89	330	480	90	0.12	11	4	1.5	17229	27229	87229	67229
		33	9.4 x 23.3	120	410	590	130	0.12	7.2	2.9	1.0	17339	27339	87339	67339
		47	10.3 x 32.0	160	540	790	190	0.12	5.1	2.7	1.0	17479	27479	87479	67479
		68	10.3 x 32.0	170	570	820	270	0.16	4.7	2.3	0.8	17689	27689	87689	67689
		100	12.9 x 32.0	220	760	1100	400	0.16	3.2	1.6	0.6	17101	27101	87101	67101

Note

(1) SAL-AG types are epoxy-filled.

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} < 0.3 \times U_R$
Maximum peak AC voltage, reverse voltage applied		≤ 2 V
Maximum peak AC voltage, without reverse voltage applied	$T_{amb} \leq 85$ °C: at $f \leq 0.1$ Hz at 0.1 Hz < $f \leq 1$ Hz at 1 Hz < $f \leq 10$ Hz at 10 Hz < $f \leq 50$ Hz at $f > 50$ Hz 85 °C < $T_{amb} \leq 125$ °C: at $f \leq 0.1$ Hz at 0.1 Hz < $f \leq 1$ Hz at 1 Hz < $f \leq 10$ Hz at 10 Hz < $f \leq 50$ Hz at $f > 50$ Hz	 $0.30 \times U_R$ $0.45 \times U_R$ $0.60 \times U_R$ $0.65 \times U_R$ $0.80 \times U_R$ $0.15 \times U_R$ $0.22 \times U_R$ $0.30 \times U_R$ $0.32 \times U_R$ $0.40 \times U_R$
Current		
Maximum leakage current	After 5 minutes at U_R and $T_{amb} = 25$ °C	$I_{L5} \leq 0.05 C_R \times U_R$ or 2 µA, whichever is greater; see Table 2
Typical leakage current	After 15 s at U_R and $T_{amb} = 25$ °C: $U_R = 6.3$ to 16 V $U_R = 25$ to 40 V	 ≈ 0.2 x value stated in Table 2 ≈ 0.1 x value stated in Table 2

VOLTAGE

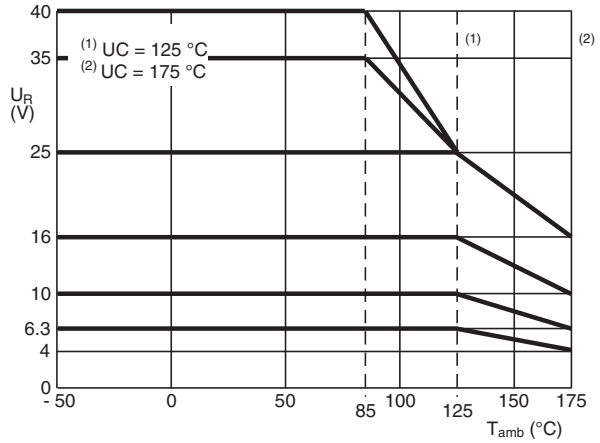


Fig.3 Maximum permissible voltage up to 175 °C

RIPPLE CURRENT (I_R)						
PARAMETER	T_{amb}					
	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

Notes

(1) Applying the maximum RMS ripple current given in Table 2 will cause a device temperature of 138 °C.

(2) The 100 kHz values in Table 2 for other temperatures are to be calculated with the above I_R multipliers.

LEAKAGE CURRENT

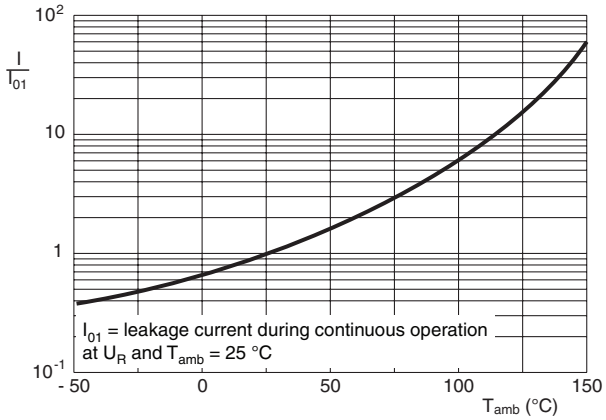


Fig.4 Typical multiplier of leakage current as a function of ambient temperature

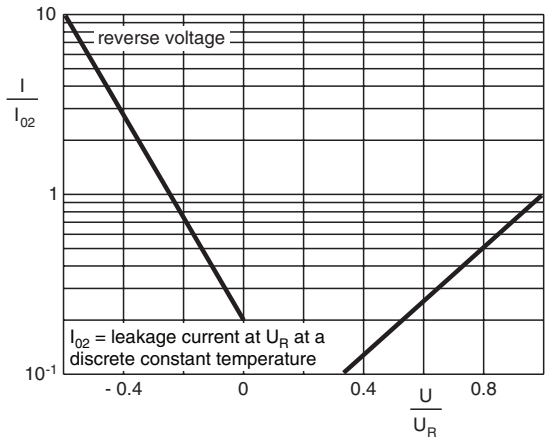


Fig.5 Typical multiplier of leakage current as a function of U/U_R

CAPACITANCE (C)

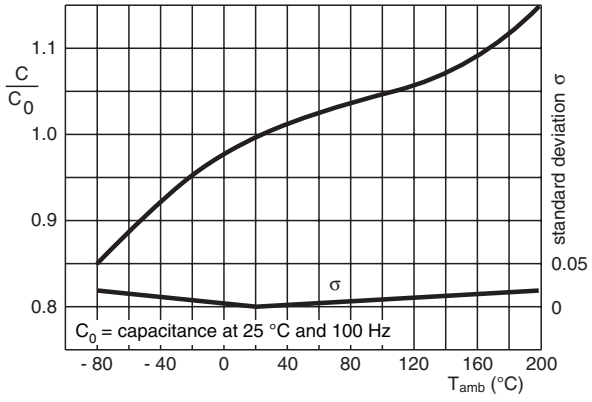


Fig.6 Typical multiplier of capacitance as a function of ambient temperature

DISSIPATION FACTOR (tan δ)

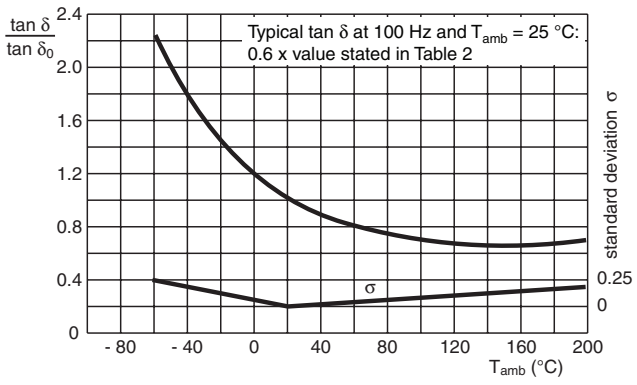


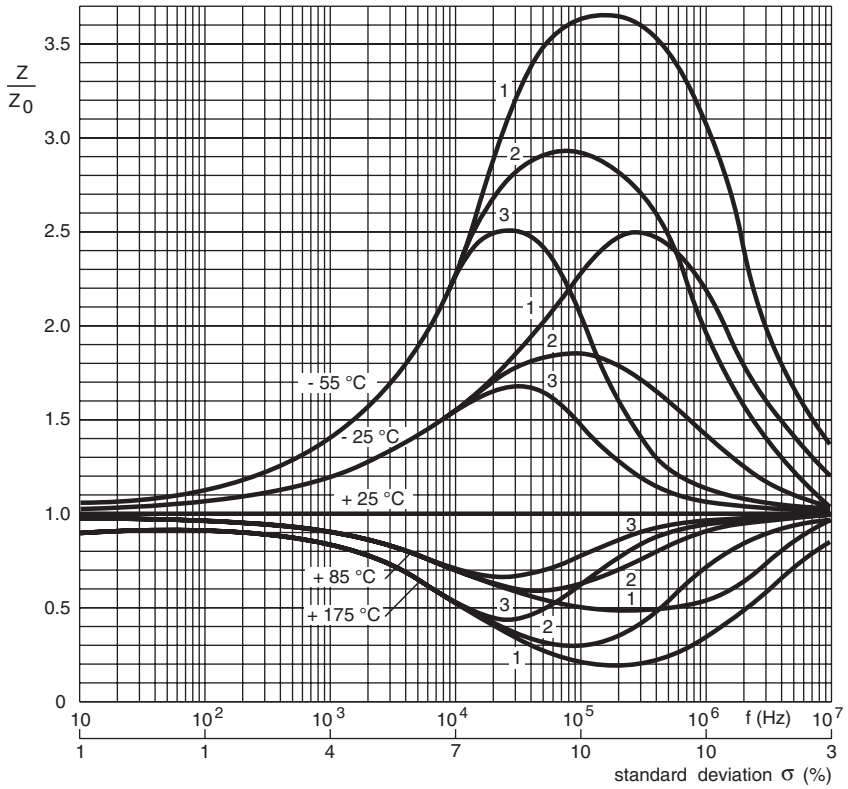
Fig.7 Typical multiplier of dissipation factor as a function of ambient temperature

MAXIMUM POWER DISSIPATION	
MAXIMUM CASE SIZE Ø D x L (mm)	**$P_{max.} = P_{125}$ (W)**
6.7 x 15.3	0.13
7.6 x 20.4	0.16
9.4 x 23.3	0.21
10.3 x 32.0	0.26
12.9 x 32.0	0.32

EQUIVALENT SERIES INDUCTANCE (ESL), f = 10 MHz			
MAXIMUM CASE SIZE Ø D x L (mm)	**PITCH (mm)**	**MAX. ESL (nH)**	**TYP. ESL (nH)**
6.7 x 15.3	20.3	30	15 to 23
7.6 x 20.4	25.4	30	16 to 24
9.4 x 23.3	27.9	35	20 to 27
10.3 x 32.0	35.6	40	26 to 33
12.9 x 32.0	35.6	55	32 to 49

IMPEDANCE (Z)

Typical impedance at 100 kHz and T_{amb} = 25 °C: 0.5 x value stated in Table 2.



Curve 1: case Ø D x L = 6.7 x 15.3 and 7.6 x 20.4 mm; 16 to 40 V
Curve 2: case Ø D x L = 6.7 x 15.3 and 7.6 x 20.4 mm; 6.3 to 10 V
Curve 3: case Ø D x L = 9.4 x 32.0, 10.3 x 32.0 and 12.9 x 32.0 mm
Z_0 = initial impedance value at any frequency and T_{amb} = 25 °C

Fig.8 Typical multiplier of impedance as a function of frequency at different ambient temperatures

IMPEDANCE (Z)

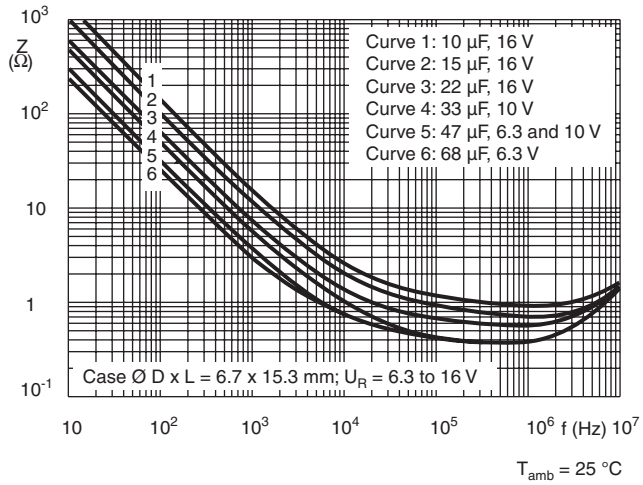


Fig.9 Typical impedance as a function of frequency

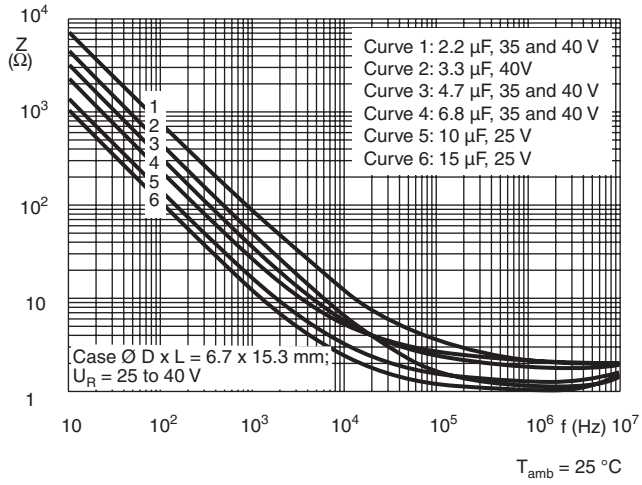


Fig.10 Typical impedance as a function of frequency

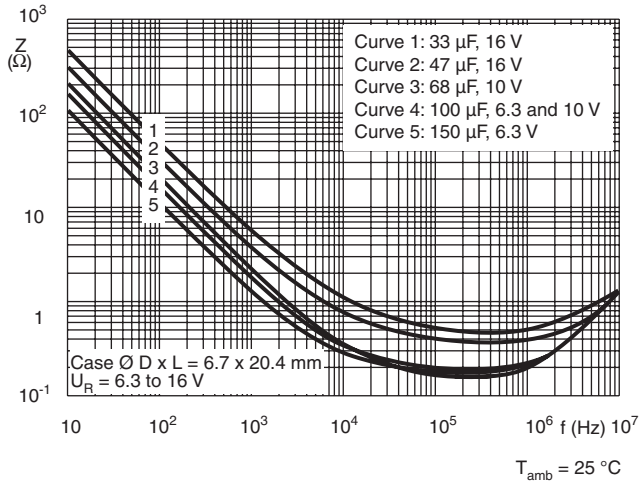


Fig.11 Typical impedance as a function of frequency

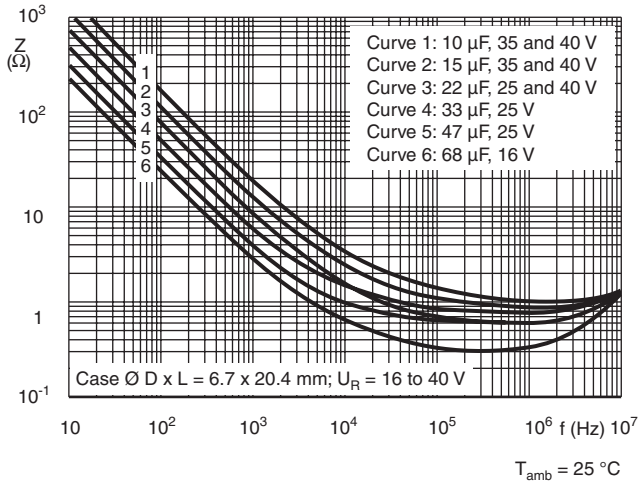


Fig.12 Typical impedance as a function of frequency

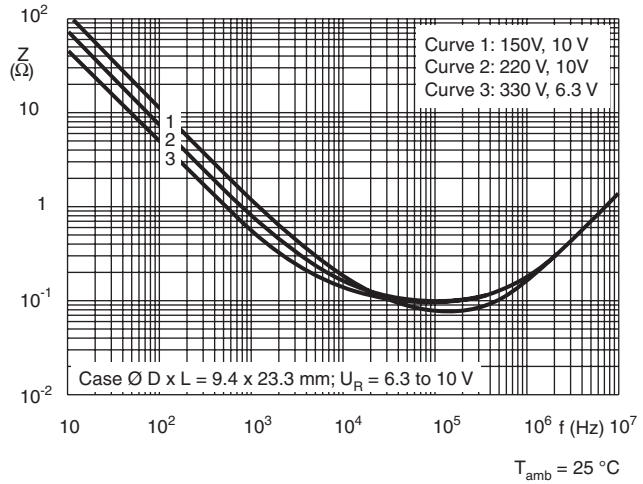


Fig.13 Typical impedance as a function of frequency

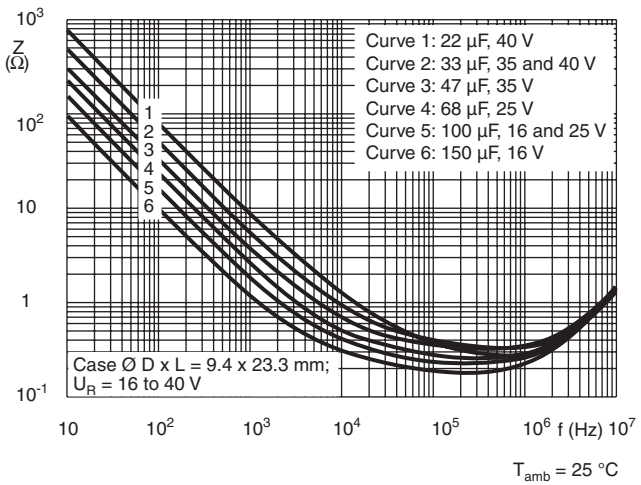


Fig.14 Typical impedance as a function of frequency

IMPEDANCE (Z)

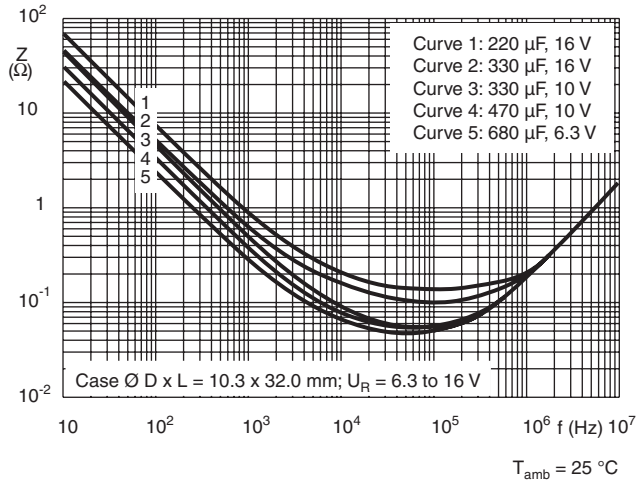


Fig.15 Typical impedance as a function of frequency

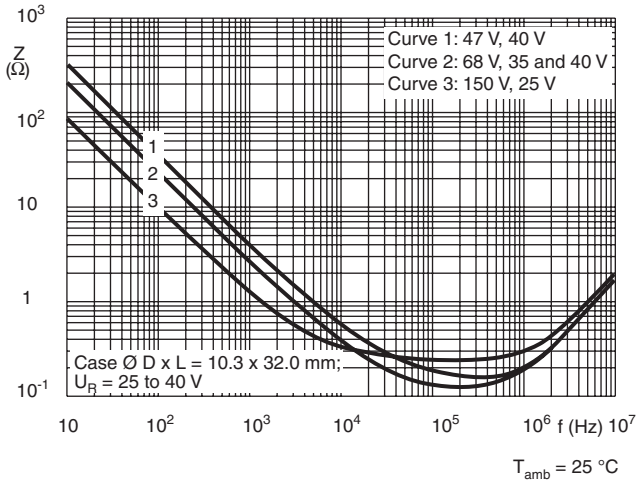


Fig.16 Typical impedance as a function of frequency

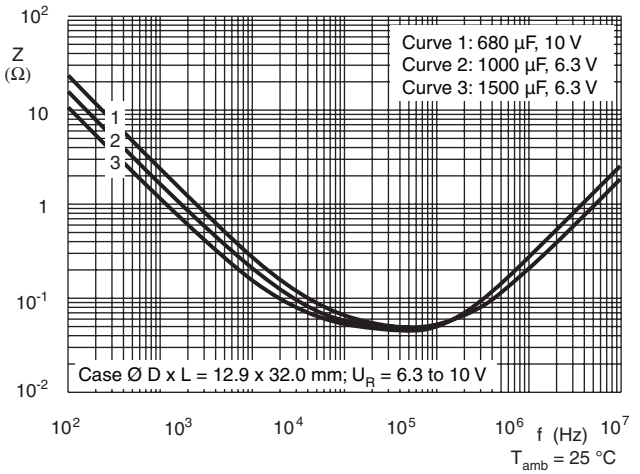


Fig.17 Typical impedance as a function of frequency

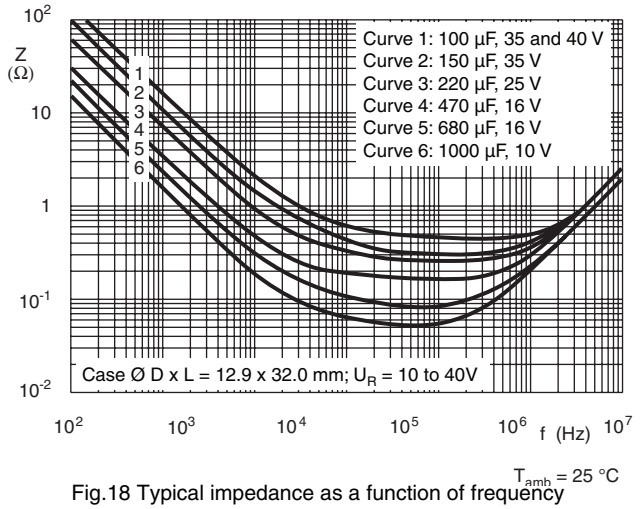


Fig.18 Typical impedance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

Typical ESR: see Figs to 24; the standard deviation is 20 % of each value.

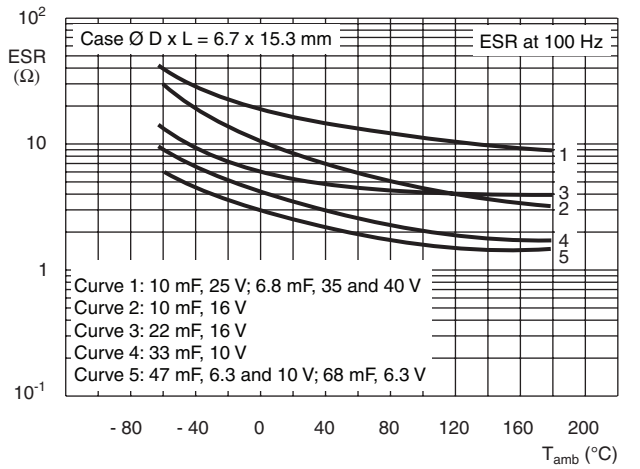


Fig.19 Typical ESR as a function of ambient temperature

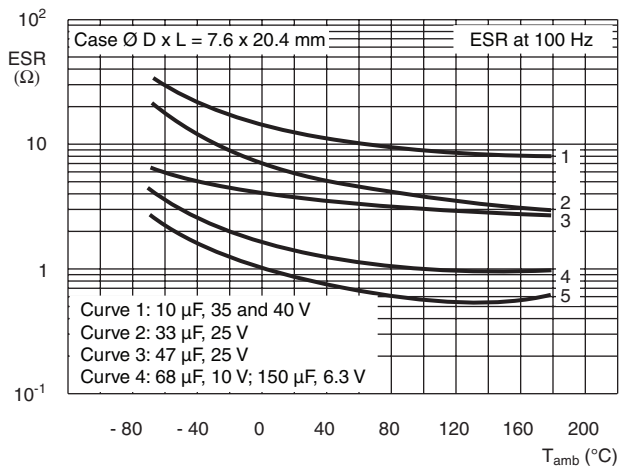


Fig.20 Typical ESR as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

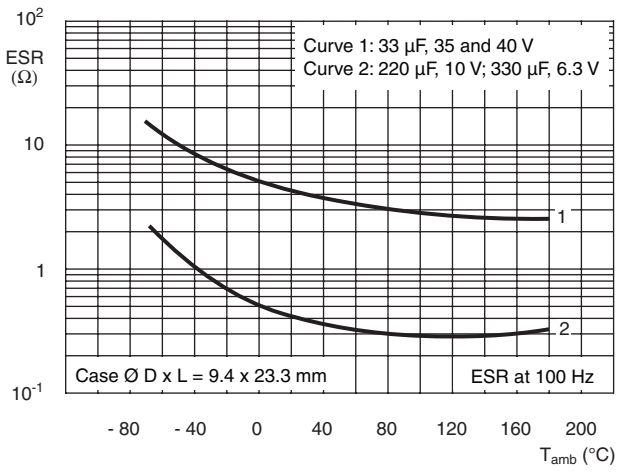


Fig.21 Typical ESR as a function of ambient temperature

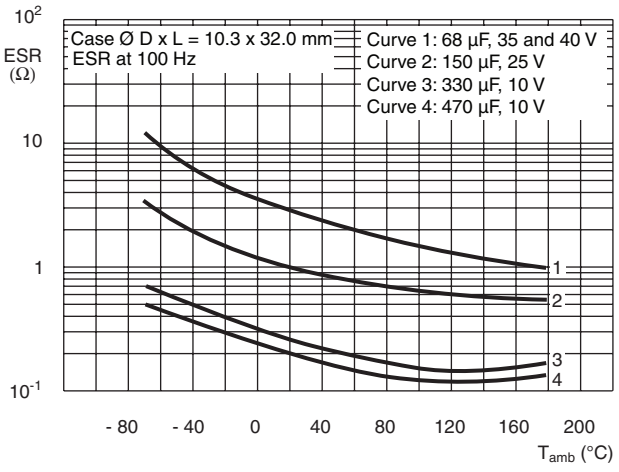


Fig.22 Typical ESR as a function of ambient temperature

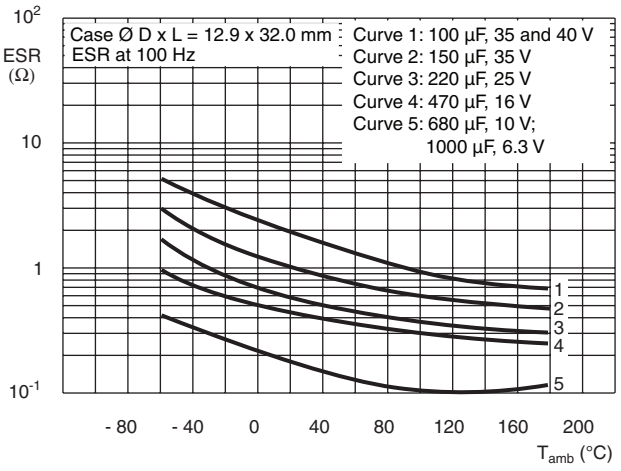


Fig.23 Typical ESR as a function of ambient temperature

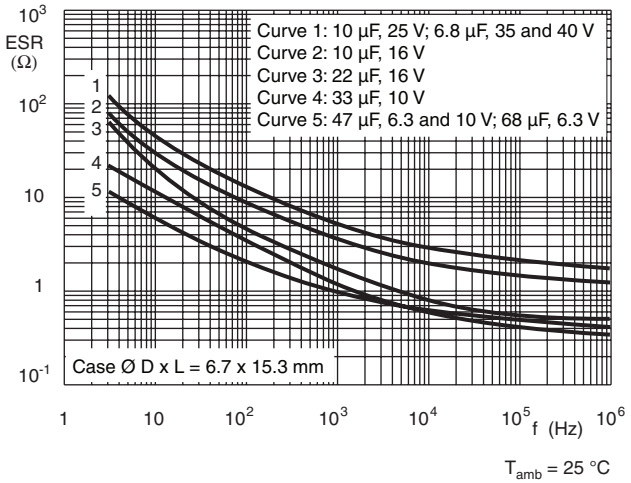


Fig.24 Typical ESR as a function of frequency

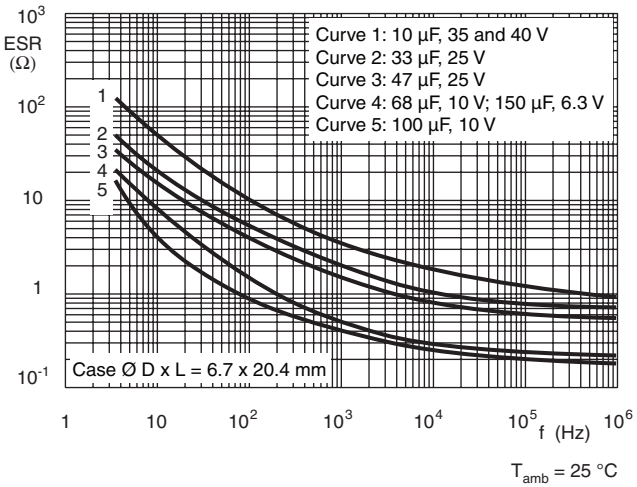


Fig.25 Typical ESR as a function of frequency

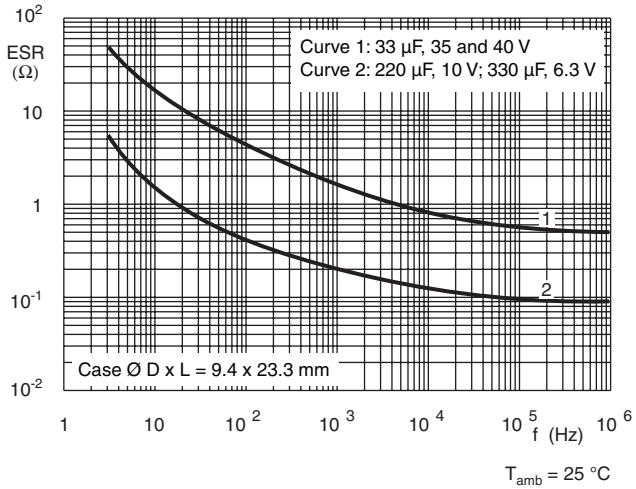


Fig.26 Typical ESR as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

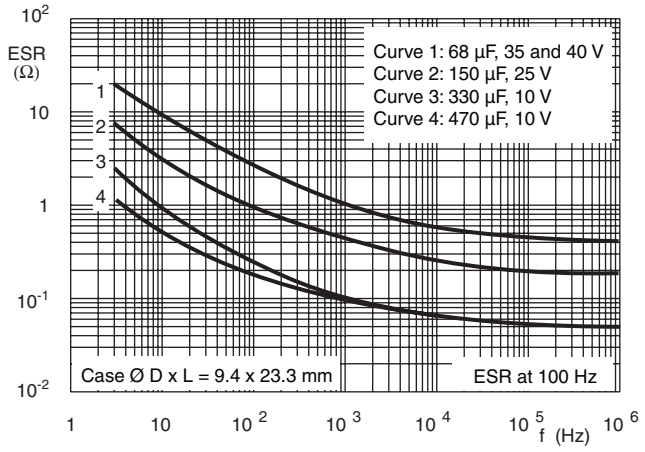


Fig.27 Typical ESR as a function of ambient temperature

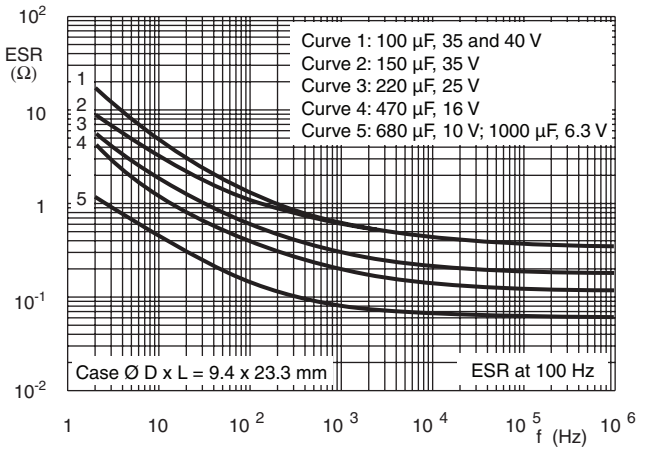


Fig.28 Typical ESR as a function of ambient temperature

Table 3

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick refeerence)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R = 6.3 to 25 V with U_R applied; U_R = 35 and 40 V with U_C applied; 10 000 hours	ΔC/C: ± 10 % tan δ ≤ 1.2 x spec. limit Z ≤ 1.2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30302 subclause 1.8.1	T_{amb} = 125 °C; I_R applied and U_R = 6.3 to 25 V with U_R applied; U_R = 35 and 40 V with U_C applied; 20 000 hours	ΔC/C: ± 15 % tan δ ≤ 1.5 x spec. limit Z ≤ 1.5 x spec. limit I_{L5} ≤ spec. limit no short or open circuit, no visible damage total failure percentage: < 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; 500 hours	ΔC/C: ± 10 % tan δ ≤ 1.2 x spec. limit I_{L5} ≤ 1 x spec. limit
Charge and discharge	IEC 60384-4-2 subclause 9.21	10^6 cycles without series resistance: 0.5 s to U_R; 0.5 s to ground	ΔC/C: ± 5 % no short or open circuit, no visible damage
Shock	IEC 60068-2-27 test Ea	half-sine or saw tooth pulse shape; 50 g; 11 ms; 3 successive shocks in each direction of 3 mutually perpendicular axes; no voltage applied	no intermittent contacts no breakdown no open circuiting no mechanical damage ΔC/C: ± 5 % tan δ ≤ 1.2 x spec. limit Z ≤ 1.2 x spec. limit I_{L5} ≤ 1.5 x spec. limit
Severe rapid change of temperature		100 cycles of 1 hour duration, each with 30 minutes at - 40 °C and + 125 °C	ΔC/C: ± 25 % tan δ ≤ 1.5 x spec. limit Z ≤ 2.0 x spec. limit I_{L5} ≤ 1 x spec.limit
Solvent resistance	IEC 60068-2-45, test XA IEC 60653	immersion: 5 ± 0.5 minutes with or without ultrasonic at 55 ± 5 °C solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
Passive flammability	IEC 60695-2-2	capacitor mounted to a vertical printed-circuit board, one flame on capacitor body; T_{amb} = 20 to 25 °C; test duration = 20 s	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s; no burning particles must drop from the sample

ADDITIONAL TESTS AND REQUIREMENTS FOR EPOXY-FILLED VERSIONS SAL-AG

2281 123 8.... Form BA ± 10 %, level S, lead (Pb)-free

2222 123 8.... Form BA ± 10 %, level S, non lead (Pb)-free

Table 4

TEST PROCEDURES AND REQUIREMENTS		
TEST	**PROCEDURE**	**REQUIREMENTS**
Severe vibration tests in accordance with *"IEC 60068-2-6"* **and** *"MIL STD-202"***, method 204, letter E, with the following details and additions**		
Method of mounting: severity 1 severity 2 severity 1 and 2	clamping both body and leads frequency range temperature 10 to 3000 Hz; 20 to 25 °C frequency range temperature 50 to 2000 Hz; 125 °C vibration amplitude: 50 g or 3.5 mm, whichever is less	ΔC/C: ± 10 % tan δ ≤ 1.2 x stated limit Z ≤ 1.4 x stated limit DC leakage current: ≤ stated limit no intermittent contacts no indication of breakdown no open circuiting no evidence of mechanical damage
Direction and duration of motion: severity 1 severity 2	 1 octave/minute; 3 directions (mutually perpendicular); 20 sweeps per direction (total 60 sweeps or 18 hours) 1 octave/minute; 2 directions (longitudinal and transversal); 3 sweeps per direction (total 6 sweeps or 1 hour)	
Functioning: severity 1 severity 2	 rated voltage applied no voltage applied	
Typical capability	> 80 g at 10 to 3000 Hz (also at 125 °C)	
Severe shock tests in accordance with *"IEC 60068-2-27"* **and** *"MIL STD-202"***, method 213, letter F, with the following details and additions:**		
Method of mounting	clamping both body and leads	ΔC/C: ± 10 % tan δ ≤ 1.2 x stated limit Z ≤ 1.4 x stated limit DC leakage current: ≤ stated limit no intermittent contacts no indication of breakdown no open circuiting no evidence of mechanical damage
Pulse shape: severity 1 severity 2 severity 3	half-sine or sawtooth 1500 g; 0.5 ms ("MIL STD-202", method 213, letter F) 3000 g; 0.2 ms 10 000 g; 0.1 ms	
Direction and number of shocks: severity 1 and 2 severity 3	 3 successive shocks in each direction of 3 mutually perpendicular axes (total 18 shocks) 1 shock in any direction	
Functioning	rated voltage applied	

Vishay Roederstein

Contents

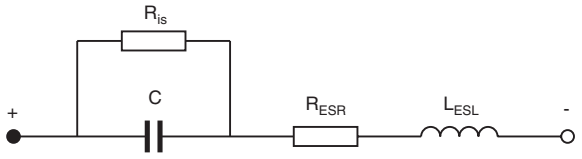
Aluminum Capacitors

SYMBOLS AND TECHNICAL TERMS	
SYMBOLS	**DESCRIPTION**
C	Capacitance
C_R	Rated capacitance
U	Voltage
U_R	Rated voltage
U_S	Surge voltage
U_B	Working voltage, operating voltage
U_{rev}	Reverse voltage
I, I~, I_{AC}	Alternating current
I_R	Rated alternating current, ripple current
I_L	Leakage current
I_{Lt}	Leakage current for acceptance test
I_{LB}, I_{OP}	Operational leakage current
R	Resistance
R_{ESR}; ESR	Equivalent series resistance
R_{is}	Insulation resistance
L	Inductance
L_{ESL}, ESL	Equivalent series inductance
tan δ	Dissipation factor (tangent of loss angle)
Z	Impedance
X	Reactance
X_C, Z_C	Capacitive reactance
X_L, Z_L	Inductive reactance
T	Temperature
T_a	Ambient temperature
T_s	Surface temperature
ΔT	Difference of temperature, temperature rise
T_{UC}	Upper category temperature
T_{LC}	Lower category temperature
f	Frequency
f_r	Resonance frequency
$\omega = 2 \pi f$	Angular frequency
F_s	Case surface area
λ	Failure rate
L	Lifetime multiplier

DESIGN AND POLARITY

The dielectric of an electrolytic capacitor with aluminum electrodes is made of aluminum oxide. One end of the dielectric sits firmly on an aluminum foil - the anode - while the other end sits on a liquid or solid electrolyte - the cathode. Power to the cathode is supplied via a second aluminum foil having a natural oxide layer as a dielectric with a blocking effect of just 1 to 2 V. (Many years of use have resulted in wrongly describing this power supply foil as 'cathode'). In its basic design the electrolytic capacitor is thus a direct current polarity-dependent capacitor (polarized style) with the positive pole being applied to the anode.

Apart from these so-called polarized electrolytic capacitors there are non-polarized capacitors available where the power supply foil is replaced by a second anode foil of the same type (non-polarized, bipolar style). This specific design allows operation with direct current of any polarity, as well as with pure alternating current.



C = capacitance of the oxide layer
R_{is} = oxide layer insulation resistance
R_{ESR} = equivalent series resistance
L_{ESL} = equivalent series inductance

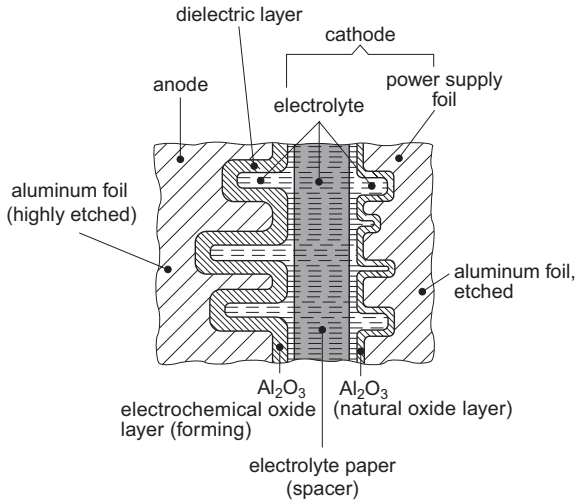


Fig.1: Basic design of an electrolytic capacitor and equivalent circuit diagram

CLASSIFICATION

Depending on applications and requirements, electrolytic capacitors are classified as:

a) Long-life grade (LL)
Electrolytic capacitors designed for increased requirements.

b) General-purpose grade (GP)
Electrolytic capacitors designed for general requirements.

Furthermore, all capacitor types have been subdivided by their application classes according to DIN 40040.

STORAGE LIFE

During transport or storage, the temperature of electrolytic capacitors is allowed to fall below their lower category temperature and reach a minimum of - 65 °C, while their upper category temperature may not be exceeded.

Depending on the design and the purity of the materials used, electrolytic capacitors offer very good storage properties. They can be stored in dry rooms at temperature ranging from - 40 °C to + 40 °C (preferably between 0 °C and + 25 °C) for up to three years without any restriction. Within that period it is possible to apply the fully-rated voltage to the capacitors without any further preparation. This procedure neither impairs the capacitor's operational reliability nor its life expectancy.

All electrolytic capacitors have a leakage current when a direct current is applied. This leakage current depends on time, voltage, and temperature. After long dead storage this leakage current will increase and, for a short time, can be 10 times greater at the time of reuse. The capacitor will not be damaged and its life expectancy will not be impaired if the rated voltage is applied directly after long storage. In general, the expected continuous operating leakage current will be re-attained or fall below its value after about 30 minutes. Any operation below the rated voltage will result in a significantly lower leakage current.

ELECTRICAL PARAMETERS

Rated Voltage U_R and Operating Voltage U_B

The rated voltage is defined as the voltage for which the capacitor has been designed and after which it is designated. The operating voltage may be smaller, but may never exceed the rated voltage value. A reduction in the operating voltage will not significantly increase the capacitor's lifetime. The capacitors may be charged with the specified rated direct voltage in the specified operating temperature range. In case of ripple alternating voltage, the peak voltage value must not exceed the rated value.

ELECTRICAL PARAMETERS (Continued)

Surge Voltage U_S

The surge voltage is defined as the maximum voltage which may be applied to the capacitor for a short time only (in one hour a maximum of five times with a duration of one minute each.) The surge voltage may not be used for periodic charge and discharge.

$U_S = 1.15 \cdot U_R$ for $U_R \leq 250$ V

$U_S = 1.10 \cdot U_R$ for $U_R > 250$ V

Ripple Alternating Voltage

The ripple voltage is defined as the effective value alternating voltage with which the capacitor may be charged in addition to direct voltage. The peak value of resulting ripple DC voltage must not exceed the rated voltage value. A reverse polarity voltage with a peak value of > 1.5 V must not occur.

Reverse Voltage U_{rev}

A reverse polarity of up to 1.5 V is permissible.

CAPACITANCE

Rated Capacitance C_R

The rated capacitance is defined as the capacitance value, after which the capacitor has been designated. The capacitance value may vary within the permissible tolerance limits.

Alternating Voltage Capacitance C_W

The AC capacitance normally corresponds to the rated capacitance value. It is determined by measuring the AC resistance at an AC voltage of ≤ 0.5 V. Since AC capacitance depends on frequency and temperature, a specific measuring frequency and temperature have to be agreed upon. IEC 60384-4 stipulates a frequency of 100 Hz and a temperature of 20 °C.

Direct Voltage Capacitance C_{DC}

The DC capacitance is determined from the quantity of charge which is stored after a DC voltage charging of the capacitor. The measurement is effected during a single discharge under specified conditions. The measuring procedures are described in DIN 41 328. If both values, C and C_{DC}, are measured at an electrolytic capacitor, the result will always be: $C < C_{DC}$.

Depending on the design $C_{DC} \approx (1.05...1.30) \times C$.

Temperature Dependence of AC Capacitance

The measured AC capacitance decreases with falling temperatures. Falling temperatures result in an increased viscosity of electrolyte and thus in an increasing ohmic resistance. In fact, a model calculation shows that the total capacitance of capacitive surface elements which are parallel connected via different series resistors R_1, R_2, etc. will decrease, if the series resistors increase. Usually this behavior is described as follows: “High-resistive coupled surface elements have a lower capacitive effect.”

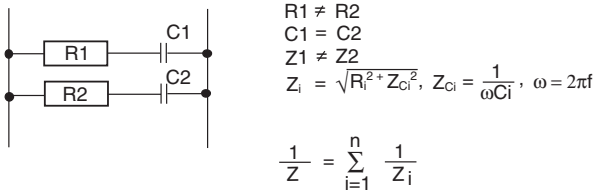


Fig.2: Detail from an equivalent circuit diagram for two surface elements

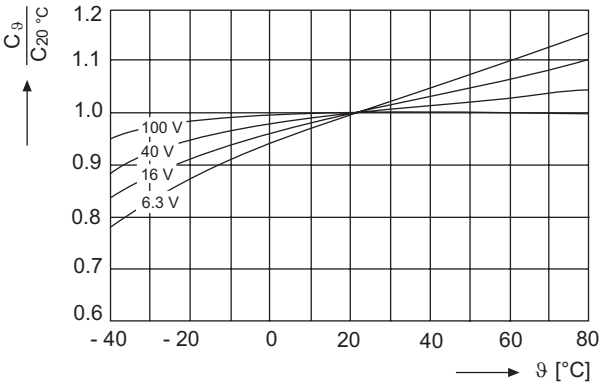


Fig.3: Typical temperature dependent behavior of AC capacitance

Frequency Dependence of AC Capacitance

The frequency dependence of AC capacitance is similar to its temperature dependence. The capacitive partial resistance Z_{Ci} decreases with increasing frequency f. At the same time the influence of the ohmic partial resistance R_i of the AC resistance Z_i is increasing. In this case, too, “high-resistive coupled surface elements have a lower capacitive effect”.

EQUIVALENT SERIES RESISTANCE R_{ESR}

The equivalent series resistance is defined as the ohmic part of the AC resistance describing the losses occurring in an electrolytic capacitor. It consists of three partial resistance values: the lead and the foil resistance, the electrolyte paper resistance, and the oxide layer resistance. Just as any other ohmic resistance, R_{ESR} is temperature-dependent, too. Moreover, it contains a frequency-dependent part - the oxide layer resistance. R_{ESR} is usually calculated from the dissipation factor tan δ as follows:

EQUIVALENT SERIES RESISTANCE R_{ESR} (Continued)

$$R_{ESR} = \frac{\tan \delta}{\omega C} = \frac{\tan \delta}{2 \cdot \pi \cdot f \cdot C}$$

R_{ESR} [Ω]
C [F]
f [Hz]

In practical operation the lower limit of the R_{ESR} is given by the ohmic part of the contact points and the foil resistance values. Thus it will not always be possible to achieve calculated values below 0.03 Ω.

The foil resistance and R_{ESR} can further be reduced by using the multiple tab technique. This technique consists of creating multiple contact points with the outer contact elements distributed uniformly across the anode and cathode foils. At the same time, the R_{ESR}-dependent capacitor values such as the dissipation factor, the impedance, and the maximum AC rating are clearly improved.

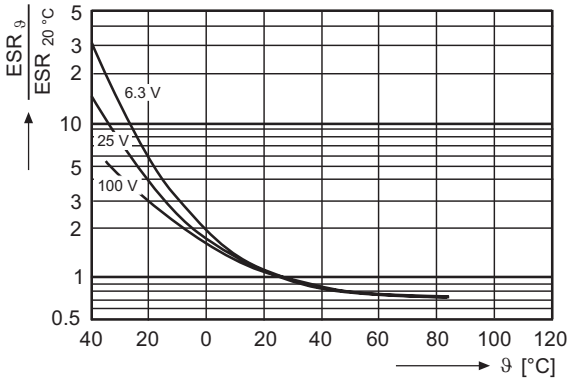


Fig.4: Temperature dependence of R_{ESR} (approx. values)

DISSIPATION FACTOR TAN δ

The dissipation factor tan δ is defined as the ratio between the equivalent series resistance R_{ESR} reactance $Z_{L,C} = \omega L - 1/\omega C$ (see Fig. 5). It is frequency-dependent via the reactance $Z_{L,C}$ and temperature dependent via the equivalent series resistance R_{ESR}.

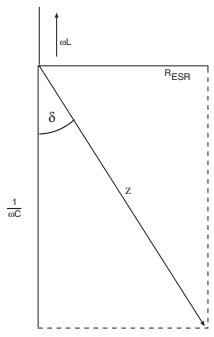


Fig.5:Vector diagram of the AC values of an electrolytic capacitor

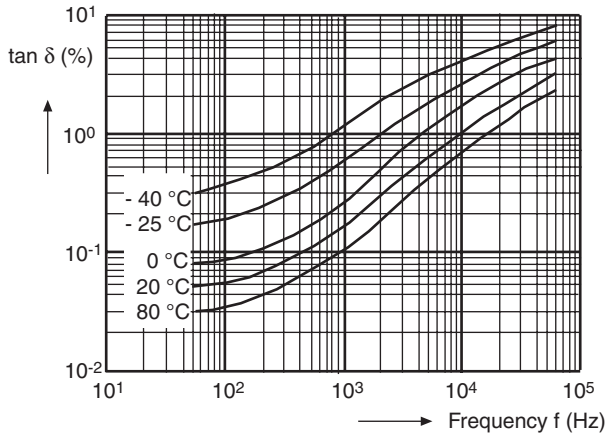


Fig.6: Typical frequency dependence of tan δ at various temperatures

IMPEDANCE Z

The amount of impedance Z of an electrolytic capacitor is calculated from the geometrical sum of the capacitive reactance $Z_C = 1 / \omega C$ of the inductive reactance $Z_L = \omega L$ and of the equivalent series resistance R_{ESR}.

$$Z = \sqrt{R^2_{ESR} + (\omega L - 1/\omega C)^2}$$

Figure 7 shows the ideal frequency curve of the impedance indicated on a double-logarithmic scale. The strong temperature dependence of the R_{ESR} value can also be seen.

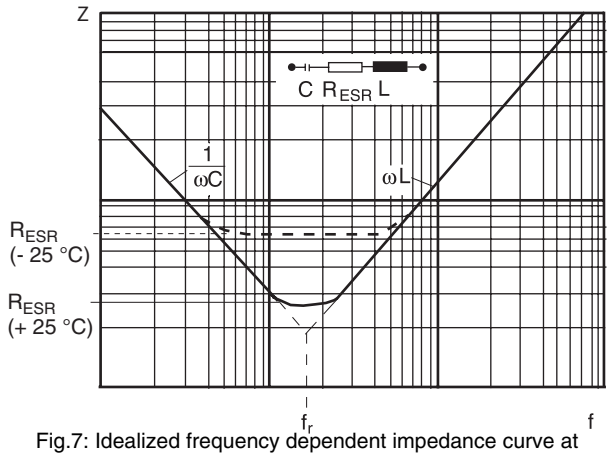


Fig.7: Idealized frequency dependent impedance curve at + 25 °C and - 25 °C

LEAKAGE CURRENT I_L

The leakage current is defined as the current flowing through the capacitor when a direct voltage is applied subsequent to the charging of the capacitor. Generally speaking, this leakage current is caused by 'defects' in the oxide dielectric. These defects range from crystal defects, stress,cracks, and installation-related damage, to a partial solution caused by the operating electrolyte. The leakage current is a measure of the 'forming state', i.e. of the regeneration to be effected on the oxide dielectric. This current depends on a multitude of factors, such as time, voltage, temperature, type of electrolyte, and 'history' of the capacitor.

Time Dependence of the Leakage Current

At the moment the measuring voltage is applied, a peak current occurs which depends on the capacitor's forming state as well as on the internal resistance of the voltage source. When the measuring voltage (charging of the capacitor) is reached, the current first drops with time until it takes on a small, nearly constant final value which ideally is only determined by the dynamic balance (temperature and voltage dependent) between the build-up and reduction of the oxide layer. This value is the operational leakage current I_{LB}. As can be expected, the operational leakage current level depends on the (measuring) voltage applied and on the temperature. Furthermore, the value of the operational leakage current is determined by the effective surface of the etched aluminum foil (capacitance of the capacitor), the type of electrolyte, and the level of the anode's (pre)forming voltage. Since the measurement of the operational leakage current, due to the long measurement period ($10 < t_M$ 60 min), will be feasible only in specific cases, shorter measurement periods of preferably one minute or five minutes have been accepted for general measurement regulations. The values measured in this way are described as leakage current for acceptance tests. In this case, the measuring voltage corresponds to the rated voltage of the capacitor.

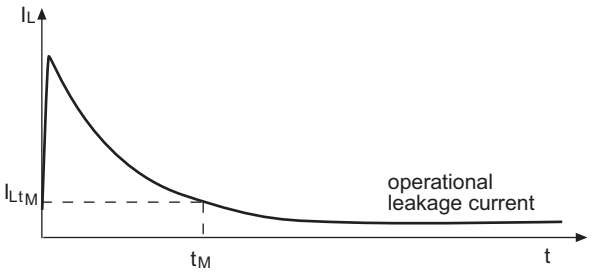


Fig.8: Typical variation with time of the leakage current

Voltage Dependence of the Leakage Current

Figure 9 shows the qualitative leakage current behavior. The leakage current I_L increases with the operating voltage U_B. The more the operating voltage approaches the (pre)forming voltage U_F of the anode, the steeper the slope (exponential rise), especially after exceeding the rated voltage U_R. The leakage current, however, loses more and more of its original meaning. Specifically in the U_S...U_F range the current can no longer be described as the measure of the regeneration work to be effected on the oxide layer. Above the surge voltage U_S there is an increasing tendency towards secondary reactions such as temperature rise, heavy formation of gas, electrolyte degradation, and inappropriate formation of oxide. For this reason any continuous operation above the rated voltage U_R is not tolerable. The conditions for exceeding the rated voltage on a short-time basis are stipulated under the heading 'surge voltage' (see surge voltage U_S).

The hatched area in Figure 9a illustrates an empirical evaluation of practical leakage current measurements. It shows the recommended approximate values for the relative leakage current dependence of U_B for $U_B \leq U_R$.

Curve A describes a small capacitor with a low rated voltage (e.g. 6 V) and a one minute leakage current value in the order of 1 µA. Curve B is typical of a middle sized high-voltage capacitor (e.g. UR = 350 V) with a 1-minute leakage current value of approximatly 100 µA (at room temperature).

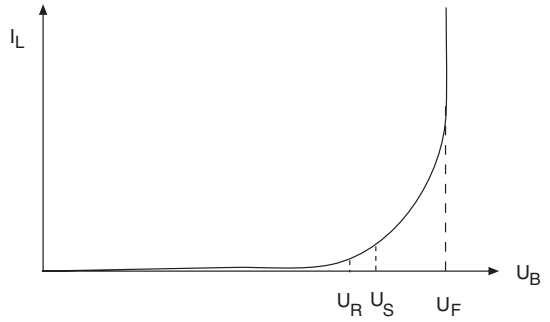


Fig.9: Typical variation of leakage current with applied voltage

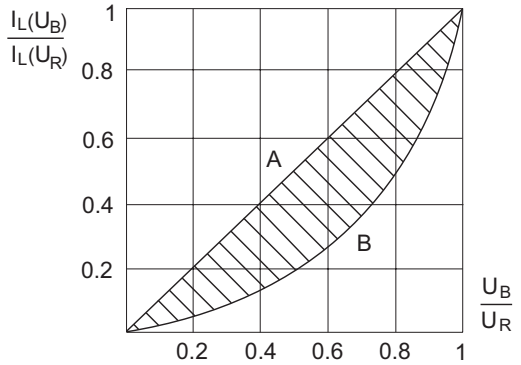


Fig.9a: Typical size dependant relation (see text)

LEAKAGE CURRENT I_L (Continued)

Temperature Dependence of the Leakage Current

Although there are numerous causes for leakage current, only one can be described as having a more clearly defined temperature dependence - i.e. the dynamic balance between partial solution and build-up of the oxide layer. As a measure of this parameter the operating leakage current I_{LB} has been introduced under section 'Time dependence of the leakage current'. The model of the rate of (electro) chemical reactions increasing with temperature can be qualitatively applied here. Hence it follows that I_{LB} increases with temperature. Figure 10 shows some empirical values.

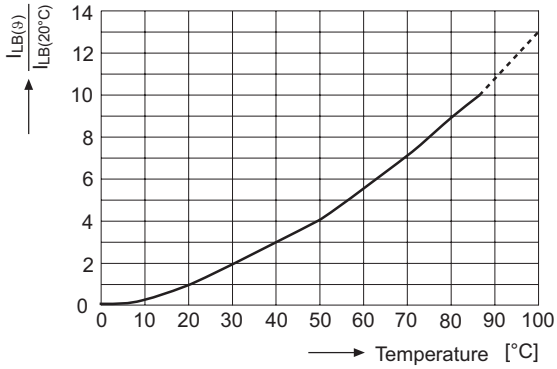


Fig.10: typical variation of leakage current with temperature

Leakage Current for Acceptance Test I_{Lt}

IEC 60384-4 and EN 130300 stipulate the measurement procedures for determining the leakage current for acceptance tests I_{Lt}. Based on these standards and due to different measuring periods (30 s, $I_{Lo.5;}$ 2 min, I_{L2}; 5 min, I_{L5}) the threshold values for the Vishay Roederstein electrolytic capacitors are those that are calculated from the leakage current equations of the respective type specifications.

ALTERNATING CURRENT

The alternating current is defined as the effective value of the alternating current with which the capacitor is charged.

Rated Alternating Current I_R

The permissible rated alternating current is defined in such a way that at an upper category temperature T_{UC} and at a frequency of 100 Hz (measuring frequency of capacitance and dissipation factor), the temperature of the case surface area rises by 3 K. The resulting AC values I_R are indicated in the data sheets for each capacitor.

Maximum Permissible Alternating Current I, AC Rating

The maximum permissible alternating current rating depends on ambient temperature T_a, case surface area F_s, equivalent series resistance R_{ESR} (or the dissipation factor tan δ), as well as on excess surface temperature ΔT (temperature rise, difference between surface temperature T_s and ambient temperature T_a). The permissible temperature rise ΔT is specified by the respective manufacturer. For Vishay Roederstein electrolytic capacitors this value is based on IEC 60384-4 and is 3 K in relation to the upper category temperature T_{uc}. Due to the temperature and frequency dependence of the equivalent series resistance R_{ESR} (or the dissipation factor tan δ) the maximum permissible alternating current is also dependent on the alternating current frequency f. Since the life expectancy of an electrolytic capacitor is considerably determined by its thermal load (permutation model, see section Lifetime), the temperature rise caused by an AC load presents a significant factor of the capacitor's lifetime. The individual lifetime tables show the interrelation between the maximum permissible alternating current I, the ambient temperature T_a, the surface temperature T_s, the alternating current frequency f, as well as the lifetime. (Sections Standard Lifetime Conversion Table and Type Specific Lifetime Conversion Table explain the use of these tables.)

ELECTRICAL STRENGTH OF THE INSULATION

The insulating sleeve can withstand a voltage of at least 1000 V.

INSULATION RESISTANCE OF THE INSULATION

The insulation resistance of the sleeve material is a minimum of 100 MΩ.

CLIMATIC CONDITIONS

For reasons of reliability and due to the temperature dependence of electrical parameters certain limits have to be observed for the climatic conditions. The upper and lower category temperature are considered important climatic conditions for electrolytic capacitors. Furthermore the degree of humidity has to be taken into account. These three values are indicated in coded form in the applicability class and IEG climatic category (see section Climatic and Applicability Categories).

Upper Category Temperature T_{UC}

The use of electrolytic capacitors is subject to specific upper temperature limits. Exceeding these limits may result in early failure of the capacitor. To avoid this, upper category temperatures are fixed which indicate the maximum permissible ambient temperature of the capacitor for continuous operation. The upper category temperature is given with the temperature range value in the data sheets. Sections Maximum Permissible Alternating Current I, AC Rating and Lifetime have shown that the electrolytic capacitor's lifetime and reliability depend considerably on the capacitor's temperature. This is why Vishay recommend using the capacitor at the lowest temperature possible to increase lifetime and reliability. Furthermore, Vishay recommend mounting the electrolytic capacitors inside the units at positions having a low ambient temperature.

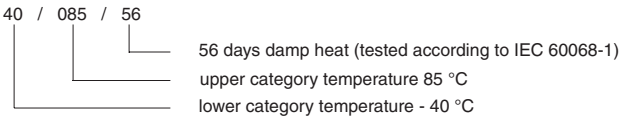
CLIMATIC CONDITIONS (Continued)

Lower Category Temperature T_{LC}

Due to an impaired electrolytic conductivity, a decreasing temperature results in higher values for impedance and dissipation factor (or R_{ESR} values). Most capacitor applications limit such an increase to specific threshold values. For this reason it is practical to stipulate a lower category temperature which is also indicated in the temperature range value given in the data sheet. It should be emphasized, however, that an operation below the specified lower category temperature is possible without damaging the capacitor. This is particularly true if the capacitor is exposed to an alternating-current load. Compared to the lower ambient temperature, the alternating current flowing through the increased equivalent series resistance can heat the electrolytic capacitor to such an extent, that its properties still ensure proper functioning of the unit.

Climatic and Applicability Categories

According to DIN 40040 the applicability class is given in form of a three-letter code. The IEC publication indicates a so-called Category (IEC Climatic Category). The data sheets list both specifications. The first letter in the DIN 40040 formula stands for the lower category temperature, the second for the upper category temperature, and the third for the permissible humidity.



DIN CLIMATIC CATEGORY

1st letter lower category temperature	F - 55 °C	G - 40 °C	H - 25 °C	
2nd letter upper category temperature	K 125 °C	M 100 °C (105 °C)	P 85 °C	S 70 °C
3rd letter relative humidity/ annual average 30 days/year max. occasional formation of dew permissible	C ≤ 95 % 100 % 100 % yes	D ≤ 80 % 100 % 90 % yes	E ≤ 75 % 95 % 85 % yes (1)	F ≤ 75 % 95 % 85 % yes

Note

(1) Rare and mild formation of dew permissible

HOW TO USE ELECTROLYTIC CAPACITORS

Date of Manufacture (Code) IEC 60062

The month and the year of manufacture are indicated. The year is given first, followed by the month.

Code (year)		Code (month)	
2000	M	January	1
2001	N	February	2
2002	P	March	3
2003	R	April	4
2004	S	May	5
2005	T	June	6
2006	U	July	7
2007	V	August	8
2008	W	September	9
2009	X	October	0
2010	A	November	N
2011	B	December	D
2012	C		
2013	D		

Example: 2007 May: V5

Alternatively it is possible to indicate the year and the week. In this case the first two figures indicate the year and the last two the week.

Example: 2003, 20th week: 0320

Pulse Handling

Vishay Roederstein electrolytic capacitors exhibit good pulse handling characteristics. However, due to continuously increased surface gain of anode foils, absolute compliance with the IEC requirement

$$\frac{\Delta C}{C} \leq \pm 10\ \%\ \text{after}\ 10^6\ \text{switching cycles}$$

cannot be guaranteed without taking specific measures, which need prior agreement.

Vibration Resistance

If not otherwise indicated in the data sheets, the IEC Publication 60068-2 is applicable: test F_C at 5 g; stress period: 1.5 hours; frequency 10 to 55 Hz, maximum displacement 0.35 mm.

Mounting Position

Care should be taken when mounting capacitors which have a pressure release valve. In vertical mounting the valve should always be at the top to avoid electrolytic leakage if the pressure valve is triggered. Similarly, when mounting the capacitor in a horizontal position the pressure valve should be in the “12- o'clock position”.

HOW TO USE ELECTROLYTIC CAPACITORS
(Continued)

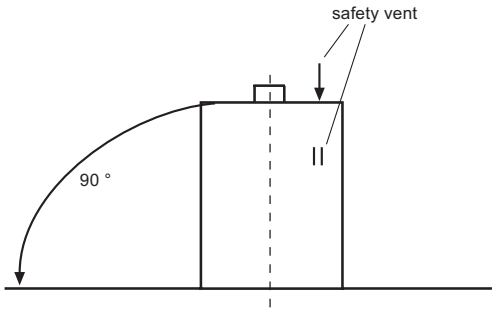


Fig.11: Recommended mounting position

We recommend not to have PC-board traces below radial aluminum electrolytic capacitors.

Low and High Pressure

Vishay Roederstein electrolytic capacitors may be used at any low pressure and at any altitude. The operating temperature should not fall below the lower category temperature. The capacitors may not be used at pressures exceeding 120 kPa.

Cleaning, Moulding

Halogenated hydrocarbons, particularly CFCs (chlorofluorocarbons), are frequently used for the cleaning of boards. There are for instance several FREON types (registered trademark of Du Pont) based on 1,1,1-Trichlorotrifluoroethane.

The manufacturers of aluminum electrolytic capacitors warn against the use of these solvents since a corrosive effect on aluminium is definitely possible. This corrosive mechanism, which may be triggered by the external influence of compounds containing CFCs, is very complex and can lead to consequential changes. Only the strict compliance with a number of clearly defined conditions can provide any protection against the penetration of solvents. We do not consider it necessary to list the conditions here but would advise you against using halogenated compounds for cleaning. Moreover, you should check whether the plastic insulation is resistant to the detergent you want to use. Ketone type solvents (e.g. acetone, methyl ethyl ketone) and ester type solvents (e.g. ethyl acetate, butyl acetate) should preferably not be used or only after checking their effect in the cleaning process. The same applies to aromatic hydrocarbons (e.g. xylenes) and aliphatic hydrocarbons (e.g. petroleum ether).

We recommend using water-based or alcohol-based detergents (e.g. ethanol, isopropanol, isobutyl alcohol, various ethylene glycols, etc.). We also recommend continuous monitoring of the cleaning bath in order to avoid the accumulation of corrosive agents (e.g. chlorides from solder residues, possibly sulphonates from surface active agents). Careful drying should immediately follow cleaning.

Similar procedures should be observed when electrolytic capacitors are varnished or moulded. Care must be taken that any varnish or moulding components such as resin, hardener, accelerator, thinner, filler, coloring matter, etc. do not contain any halogen.

ELECTROLYTE

The operating electrolyte is an electrically conductive liquid. Its composition differs according to type and voltage range. A polar organic liquid of a high boiling point with a certain amount of salt provides its ionic conductivity. Halogenated hydrocarbons are not used. Water may occur as a constituent of the electrolyte. The salts used can be organic or inorganic.

The electrolytes can be mixed with water. Since they have an almost neutral pH value, there will be no acidic or caustic reaction. Its flash point is always above 80 °C. They do not contain any easily or highly ignitable agents and no explosive substances.

Great attention is given to selecting only those electrolytic constituents that combine the least possible toxicity with the utmost environmental compatibility. Unfortunately the present state of technological development does not always enable us to fully avoid the use of substances which are considered harmful. However, we do not use highly toxic, carcinogenic, or questionable compounds. Extreme care should be taken when handling electrolytic liquid that has leaked out.

- Avoid skin contact
- Do not inhale vapors
- Provide sufficient ventilation

If the electrolyte has come into contact with your skin, mucous membrane, or eyes, immediately rinse carefully for several minutes under running water. Remove affected clothing. Seek medical attention if you have swallowed any liquid.

We would like to remind you that the following errors will trigger the safety mechanism and may result in a discharge of electrolytic fluid:

- reverse polarity
- excessive voltage
- excessive current load
- overheating

DISPOSAL OF USED ALUMINUM ELECTROLYTIC CAPACITORS

Due to potential harmful effects to the environment, special regulations have to be observed which dictate the disposal of capacitors as toxic waste.

Important remarks:
The aluminum electrolytic capacitors do not contain any polychlorinated biphenyls (PCB) or similar substances that may produce dioxins when burning. Moreover, during manufacture we do not use any substances that may harm the ozone layer.

OPERATIONAL RELIABILITY

The specifications regarding the reliability of electrolytic capacitors refer to:

1) the failure rate during operation

2) the beginning of wear-out failures (end of lifetime)

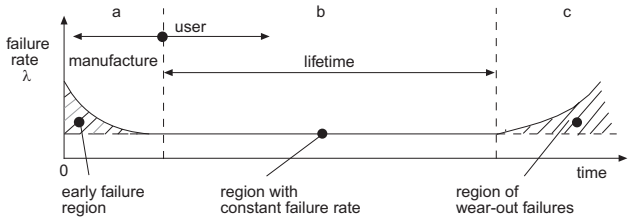


Fig.12: Failure rate (λ) as a function of time ('bath-tub life curve')

Early failures (region a) of electrolytic capacitors occur during the manufacturing process and are eliminated. We normally expect a constant low failure rate (λ) during the stated lifetime of capacitors (region b). Subsequently the electrolytic capacitors will tend to suffer failures due to drying out (region c).

Endurance Test

IEC 60384-4 and EN 130300 define the criteria for permissible changes in the values of electrical parameters following endurance tests at rated voltage and upper category temperature. The duration and the conditions for the specific capacitor types are given in the respective separate specifications. The endurance test does not allow any direct assessment of the lifetime of an electrolytic capacitor. Therefore the duration of the test must not be confused with the indicated lifetime of the respective capacitor type.

If one of the following conditions is not met, the capacitor has failed the test.

FAILURE CRITERIA FOR ENDURANCE TEST

CRITERIA	VOLTAGE RANGE V	CHANGE IN CAPACITANCE (%)	RATIO OF FINAL VALUE TO SPECIFIED THRESHOLD VALUE		
			tan δ	Z	I_L
A	$6.3 \le U_R$ $6.3 < U_R \le 160$ $160 < U_R$	$-40 \le \Delta C/C \le +25$ $-30 \le \Delta C/C \le +30$ $-15 \le \Delta C/C \le +15$	≤ 1.5	≤ 3	≤ 1
B	$6.3 \le U_R$ $6.3 < U_R \le 160$ $160 < U_R$	$-30 \le \Delta C/C \le +15$ $-15 \le \Delta C/C \le +15$ $-10 \le \Delta C/C \le +10$	≤ 1.3	≤ 2	≤ 1
C	$16 \le U_R$ $16 > U_R$	$-25 \le \Delta C/C \le +25$ $-20 \le \Delta C/C \le +20$	≤ 1.5 ≤ 1.5	- -	≤ 1
D		$-20 \le \Delta C/C \le +20$	≤ 2	≤ 2	≤ 1
E		$-15 \le \Delta C/C \le +15$	≤ 1.5	≤ 2	≤ 1
F		$-20 \le \Delta C/C \le +20$	≤ 2	-	≤ 1
G		$-20 \le \Delta C/C \le +20$	≤ 1.5	-	≤ 1

OPERATIONAL RELIABILITY (Continued)

Lifetime

The lifetime is defined as the period during which a specified failure rate is not exceeded under given operating conditions and under specified failure criteria. The indicated lifetime usually is based on a 60 % upper confidence level.

The lifetime is continuously confirmed by accelerated sample tests at the upper category temperature. At temperatures > 40 °C for every temperature rise of 10K the acceleration factor for electrolytic capacitors is assumed to halve the lifetime at the same failure rate (10K rule).

In principle, the lifetime is determined by the loss of electrolyte. The degree of electrolyte loss (diffusion through the sealing elements) depends on the time, the electrolytic vapor pressure, the individual interaction of electrolytic solvent with the sealing materials and geometric factors.

For practical purposes, the temperature dependence is described by way of an equation which was used by Arrhenius to describe the effect of temperature on the rate of chemical reactions. The frequently used 10 K-rule only provides a practical approximation formula for usual temperature range.

Failure Criteria for Lifetime Indication

Based on IEC 60384-4 or EN1300300, the indicated lifetime values are defined as follows:

a) load factors
- rated voltage U_R
- rated alternating current I_R
- upper category temperature T_{UC}

b) failure criteria

FAILURE	PARAMETER	LL GRADE (LONG)	GP GRADE
complete	all	short circuit or break	
change failure	tan δ or R_{ESR}	> 3 x initial threshold value	
	I_L	> initial threshold value	
	Z	> 3 x initial threshold value	
	ΔC/C	> ± 30 %	> ± 40 %

The ratio between complete failure and change failure should be 1:9

Failure Rate

The failure rate λ (fit = failure time) is defined as the quotient of the number of failures, and the product of the number of test components and the test period (component operating time).

$$\lambda = \frac{\text{number of failures}}{\text{number of test components x test period}}$$

The failure rate provides the basis for reliability forecasts. Usually the failure rate is given with the unit 10^{-9}/h = 1 fit (failure in time) at an UCL (Upper Confidence Level) of 60 %. The failure rates indicated apply to T_a = 40 °C U_B = 0.5 x U_R. The failure rate is temperature and voltage dependent. The conversion table given below shall be used in the case of other conditions.

Load Voltage

RATED VOLTAGE LOAD	CONVERSION FACTOR
100 %	2.0
75 %	1.4
50 %	1.0
25 %	0.8
10 %	0.6

TEMPERATURE	CONVERSION FACTOR
≤ 40 °C	1
55 °C	3
70 °C	8
85 °C	20
105 °C	90
125 °C	360

Cumulative Failure Frequency

The share of failed components during a stress period (to be specified).

STANDARD LIFETIME CONVERSION TABLE

The lifetime conversion table is used to describe the relation between user current, ambient temperature and lifetime at various frequencies. It should be used to determine lifetime under the conditions in the application. The following standard table applies to all types where no specific conversion table has been integrated in the data sheet. The table indicates minimum values.

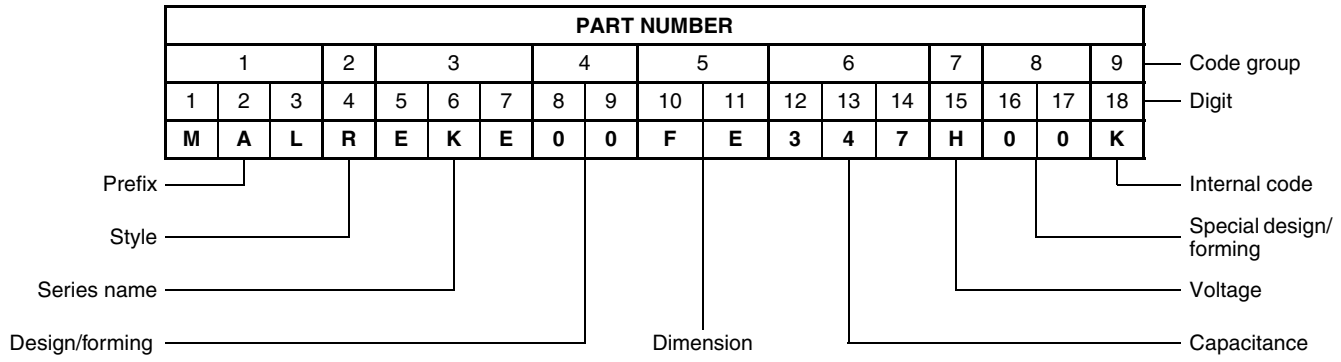
STANDARD LIFETIME CONVERSION TABLE

For all surface mount and radial series

I/I_R (FREQUENCY DEPENDENT)						Surface temperature rise	LIFETIME MULTIPLIER L (depending on I/I_R and T_a)													
FREQUENCY [Hz]							AMBIENT TEMPERATURE T_a [°C]													
50	100	250	500	1000	> 2500	ΔT_s (°C)	T_{UC} - 85	T_{UC} - 75	T_{UC} - 65	T_{UC} - 55	T_{UC} - 45	T_{UC} - 40	T_{UC} - 35	T_{UC} - 30	T_{UC} - 25	T_{UC} - 20	T_{UC} - 15	T_{UC} - 10	T_{UC} - 5	T_{UC}
0.2	0.2	0.2	0.2	0.2	0.2	0.1	596	298	149	75	37	26	19	13	9.3	6.6	4.7	3.3	2.33	1.65
0.4	0.4	0.4	0.4	0.4	0.5	0.5	560	280	140	70	35	25	18	12	8.8	6.2	4.4	3.1	2.19	1.55
0.6	0.6	0.6	0.6	0.7	0.7	1.2	505	252	126	63	32	22	16	11	7.9	5.6	3.9	2.8	1.97	1.39
0.7	0.8	0.8	0.9	0.9	0.9	2.1	437	218	109	55	27	19	14	9.6	6.8	4.8	3.4	2.4	1.71	1.21
0.9	1.0	1.1	1.1	1.1	1.2	3.3	362	181	91	45	23	16	11	8.0	5.7	4.0	2.8	2.0	1.41	1.00
1.1	1.2	1.3	1.3	1.3	1.4	4.8	288	144	72	36	18	13	9.0	6.4	4.5	3.2	2.3	1.6	1.13	
1.3	1.4	1.5	1.5	1.6	1.6	6.5	220	110	55	27	14	9.7	6.9	4.9	3.4	2.4	1.7	1.2		
1.5	1.6	1.7	1.7	1.8	1.9	8.4	161	80	40	20	10	7.1	5.0	3.6	2.5	1.8	1.3			
1.7	1.8	1.9	1.9	2.0	2.1	11	113	56	28	14	7.1	5.0	3.5	2.5	1.8	1.2				
1.9	2.0	2.1	2.2	2.2	2.3	13	76	38	19	9.5	4.8	3.4	2.4	1.7	1.2					
2.1	2.2	2.3	2.4	2.5	2.6	16	49	25	12	6.1	3.1	2.2	1.5	1.1						
2.2	2.4	2.5	2.6	2.7	2.8	19	30	15	7.6	3.8	1.9	1.3								
2.4	2.6	2.7	2.8	2.9	3.0	22	18	9.1	4.5	2.3	1.1				**combination**					
2.6	2.8	2.9	3.0	3.1	3.3	26	10	5.2	2.6	1.3					**not**					
2.8	3.0	3.2	3.2	3.3	3.5	30	5.7	2.8	1.4						**permitted**					
3.0	3.2	3.4	3.5	3.6	3.7	34	3.0	1.5												
3.2	3.4	3.6	3.7	3.8	4.0	38	1.5													

T_{UC} upper category temperature (°C)
I user current (A)
I_R 100 Hz alternating current (A) at upper category temperature T_{UC} taken from respective data sheet.
T_a ambient temperature of electrolytic capacitor (°C)
ΔT_s surface temperature rise of electrolytic capacitor due to user current (°C)
L lifetime multiplier

PRODUCT CODE



Code Group 1
Consists of three characters which indicate the Aluminum Capacitor Division (Material Aluminum).

Code Group 2
Consists of one character which indicates the style of the product.
A = Axial
I = Snap In
L = Solder Lug
P = Solder Pin
R = Radial
S = SMD
T = Screw Terminal
M = Accessories

Code Group 3
Consists of three characters which provide the code indicating the respective series.
Examples of series codes:
EKA, EKB, EKF, EKE, ELM, EBM, EB, EL, EYH, EYN, ECA, ECV

Note: For two letter type-codes the third place (7th digit) is a zero.

Code Group 4
Consists of two digits which provide the numerical code for specifying a particular design.

Description:
8th digit:

0 = Standard design, polarized
2 = Bipolar, non-polarized
9 = Special, customized

9th digit:

0 = Standard design
3 = Mounting ring (for axial products only)
5 = Cut leads (for radial products only), wires cut to 4.5 mm (3 mm and 4 mm on request)
6 = Radial types with Snap-In leads and shortened (for diameter $10 \leq \varnothing D \leq 18$ mm only)
7 = Radial types with Snap-In pins
8 = Radial types with Snap-In pins
9 = Radial types, with Snap-In leads, shortened and bent open to 5.0 mm (for diameter $\varnothing D \leq 8$ mm only)

PRODUCT CODE (continued)

Consists of two letters indicating the capacitor's (nominal) dimensions. The 10th digit stands for yhe diameter D and the 11th for the length L.

Code Group 5

RADIAL TYPES	
10th digit D(mm)	11th digit L (mm)
3 = N	5 = P
4 = M	7 = M
5 = A	9 = Z
6.3 = B	10 = V
8 = P	11 = A
8.5 = C	11.5 = B
10 = D	12 = T
12.5 = F	12.5 = C
13 = G	16 = D
14 = H	20 = E
16 = J	22 = F
18 = K	25 = G
22 = L	27 = N
25 = P	30 = J
25.4 = R	31.5 = S
	35 = U
	35.5 = L
	36.5 = R
	41 = K
	45 = W
	51 = X

AXIAL TYPES	
10th digit D (mm)	11th digit L (mm)
3.3 = A	7 = M
4.5 = B	8 = N
6 = C	10 = K
6.5 = D	11 = A
8 = F	17 = B
10 = G	18 = L
12 = H	20 = C
14 = J	25 = D
16 = K	30 = E
18 = L	35 = F
21 = M	40 = G
25 = N	45 = H
30 = P	50 = J

CAN TYPES	
10th digit D (mm)	11th digit L (mm)
20 = S	20 = W
22 = L	25 = U
25 = A	30 = V
30 = B	35 = A
35 = C	40 = B
40 = D	45 = C
45 = M	50 = D
50 = E	55 = E
55 = F	60 = F
60 = G	65 = H
65 = H	70 = G
76 = K	80 = J
	90 = K
	105 = M
	114 = O
	120 = P
	125 = R
	135 = S
	144 = T
	166 = X

SMD
10, 11th digit D x L (mm)
AA = 3 x 5.3
BA = 3 x 5.8
BB = 4 x 5.3
AB = 4 x 5.8
BC = 5 x 5.3
AC = 5 x 5.8
BD = 6.3 x 5.3
AD = 6.3 x 5.8
BM = 6.3 x 7.7
AE = 8 x 6.5
AF = 8 x 10
AG = 10 x 10
AH = 12.5 x 13.5
BH = 12.5 x 16.5
AK = 16 x 16.5
AM = 16 x 21.5
AN = 18 x 16.5
AP = 18 x 21.5

Code Group 6

Consists of three digits which indicate the capacitance values.

12th digit:	Number of place before the decimal point
13th and 14th digit:	Capacitance value

Example:

047 = 0.47 µF	347 = 470 µF
147 = 4.7 µF	447 = 4700 µF
247 = 47 µF	547 = 47 000 µF

Code Group 7

Consists of one place (15th place) and provides the letter code indicating the capacitor's rated DC voltage (V).

A	B	C	D	Z	E	F	G	H	U	J	W	L	M	S	N	V	O	K	R	X	P	Y
4	6.3	10	16	33	25	35	40	50	60	63	80	100	160	200	250	300	350	360	385	400	450	500

PRODUCT CODE (continued)

Code Group 8

Consists of two figures (16th and 17th place) which indicate the capacitance tolerances and special designs.

Description:

16th and 17th digit:	DIN IEC 62 coding:
00 = Standard design	
02 = Standard design for can types (pin length 6.3 mm)	
03 = Lead length 3.0 mm (in combination with code group 4 only)	
04 = Lead length 4.0 mm (in combination with code group 4 only)	
05 = Capacitance tolerance - 10 % ... + 50 %	T
06 = Capacitance tolerance - 10 % ... + 30 %	Q
07 = Capacitance tolerance ± 10 %	K
08 = Capacitance tolerance ± 15 %	
09 = Capacitance tolerance ± 20 %	M

Note:

05 or 09 is only mentioned if there is a deviation of the standard tolerance

10 to 99 = Other special designs

The 16th digit can also be taken by a letter which in this case indicates the type of packaging.

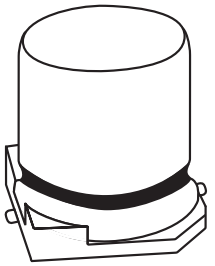
Description:

LETTER CODE	STYLE	CASE DIAMETER (mm)	TYPE OF PACKAGING	LEAD SPACING (mm)
A	Axial	3.3 ≤ 16	Reel	N/a
B	Axial	3.3 ≤ 16	Ammo	N/a
M	Radial	3 ≤ 6.3	Ammo	2.5
N	Radial	8	Ammo	3.5
L	Radial	4 ≤ 8	Ammo	5.0
G	Radial	10 ≤ 12.5	Ammo	5.0
G	Radial	16 ≤ 18	Ammo	7.5

Code Group 9

Consists of one character (18th digit) and is reserved for an internal coding.
(e.g. production line, production location, etc.)

Aluminum Capacitors



FEATURES

- Polarized aluminum electrolytic capacitors
- SMD style
- High CU-product
- Miniature dimension
- Reflow soldering
- RoHS compliant

Pb-free

RoHS COMPLIANT

QUICK REFERENCE DATA		
DESCRIPTION	**UNIT**	**VALUE**
Nominal case size (Ø D x L)	mm	4 x 5.3 to 12.5 x 13.5
Rated capacitance range C_R	µF	0.10 to 2200
Capacitance tolerance	%	± 20
Rated voltage range	V	6.3 to 100
Category temperature range	°C	- 40 to + 85
Load life	h	2000
Based on sectional specification		IEC 60384-4/EN 130300
Climatic category IEC 60068		40/105/56

APPLICATIONS

- General use
- Consumer electronics
- Low-headroom, height restricted low mass units
- Filtering, smoothing, coupling

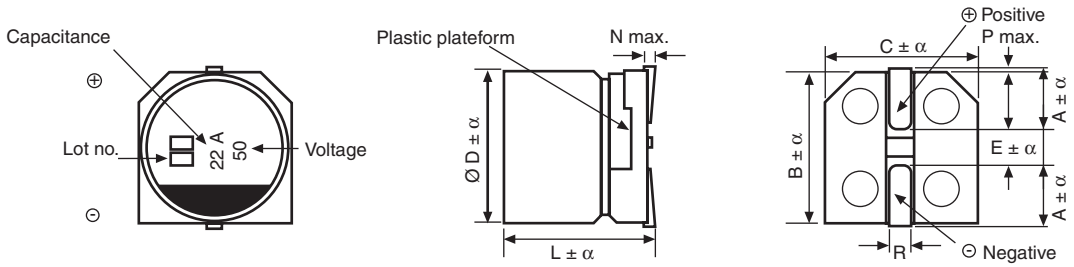
PACKAGING

- Supplied in blister tape

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	RATED VOLTAGE (V)							
	6.3	**10**	**16**	**25**	**35**	**50**	**63**	**100**
0.10	→	→	→	→	→	4 x 5.3	-	-
0.22	→	→	→	→	→	4 x 5.3	-	-
0.33	→	→	→	→	→	4 x 5.3	-	-
0.47	→	→	→	→	→	4 x 5.3	-	-
1.0	→	→	→	→	→	4 x 5.3	-	-
2.2	→	→	→	→	→	4 x 5.3	→	5 x 5.3
3.3	→	→	→	→	→	4 x 5.3	→	6.3 x 5.8
4.7	→	→	→	→	→	5 x 5.3	→	6.3 x 5.8
10	→	→	→	→	4 x 5.3	5 x 5.3	6.3 x 5.8	8 x 10
22	→	→	→	5 x 5.3	→	6.3 x 5.3	8 x 6.2	8 x 10
33	→	→	→	5 x 5.3	6.3 x 5.3	6.3 x 7.7	8 x 10	10 x 10
47	→	→	5 x 5.3	6.3 x 5.3	8 x 6.2	8 x 10	→	10 x 10
68	→	→	→	→	→	→	→	12.5 x 13.5
100	5 x 5.3	→	6.3 x 5.3	8 x 6.2	8 x 10	10 x 10	→	12.5 x 13.5
220	→	8 x 6.2	6.3 x 7.7	8 x 10	→	10 x 10	12.5 x 13.5	-
330	6.3 x 7.7	→	8 x 10	→	10 x 10	12.5 x 13.5	-	-
470	→	8 x 10	→	10 x 10	12.5 x 13.5	-	-	-
1000	8 x 10	10 x 10	→	12.5 x 13.5	-	-	-	-
1500	10 x 10	→	12.5 x 13.5	-	-	-	-	-
2200	→	12.5 x 13.5	-	-	-	-	-	-

DIMENSIONS in millimeters									
CASE SIZE CODE	D ± α	L ± α	A ± α	B ± α	C ± α	E ± α	R	N	P
BB	4 ± 0.5	5.3 ± 0.2	1.9 ± 0.2	4.3 ± 0.2	4.3 ± 0.2	1.0 ± 0.2	0.5 ~ 0.8	0.3	0.5
BC	5 ± 0.5	5.3 ± 0.2	2.3 ± 0.2	5.3 ± 0.2	5.3 ± 0.2	1.4 ± 0.2	0.5 ~ 0.8	0.3	0.5
BD	6.3 ± 0.5	5.3 ± 0.3	2.4 ± 0.2	6.6 ± 0.2	6.6 ± 0.2	2.2 ± 0.2	0.5 ~ 0.8	0.3	0.5
AD	6.3 ± 0.5	5.8 ± 0.3	2.4 ± 0.2	6.6 ± 0.2	6.6 ± 0.2	2.2 ± 0.2	0.5 ~ 0.8	0.3	0.5
BM	6.3 ± 0.5	7.7 ± 0.4	2.4 ± 0.2	6.6 ± 0.2	6.6 ± 0.2	2.2 ± 0.2	0.5 ~ 0.8	0.3	0.5
AE	8 ± 0.5	6.2 ± 0.4	3.3 ± 0.2	8.3 ± 0.2	8.3 ± 0.2	2.3 ± 0.2	0.5 ~ 0.8	0.3	0.5
AF	8 ± 0.5	10 ± 0.5	2.9 ± 0.2	8.3 ± 0.2	8.3 ± 0.2	3.1 ± 0.2	0.8 ~ 1.1	0.3	0.5
AG	10 ± 0.5	10 ± 0.5	3.2 ± 0.2	10.3 ± 0.2	10.3 ± 0.2	4.5 ± 0.2	0.8 ~ 1.1	0.3	0.5
AH	12.5 ± 0.5	13.5 ± 0.5	4.6 ± 0.2	12.8 ± 0.2	12.8 ± 0.2	4.5 ± 0.2	1.1 ~ 1.4	0.3	0.5
AK	16 ± 0.5	16.5 ± 0.5	5.6 ± 0.2	16.8 ± 0.2	16.8 ± 0.2	6.5 ± 0.2	1.1 ~ 1.4	0.3	0.5



ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	max. equivalent series resistance at 120 Hz
I_R	rated alternating current at 120 Hz and upper catagory temperature

Note

Unless otherwise specified, all electrical values apply at T_{amb} = 20 °C, P = 80 to 120 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

ECA 33 µF/25 V, ± 20 %, size 5 x 5.3 mm

Ordering code: MALSECA00BC233EARK

For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service.

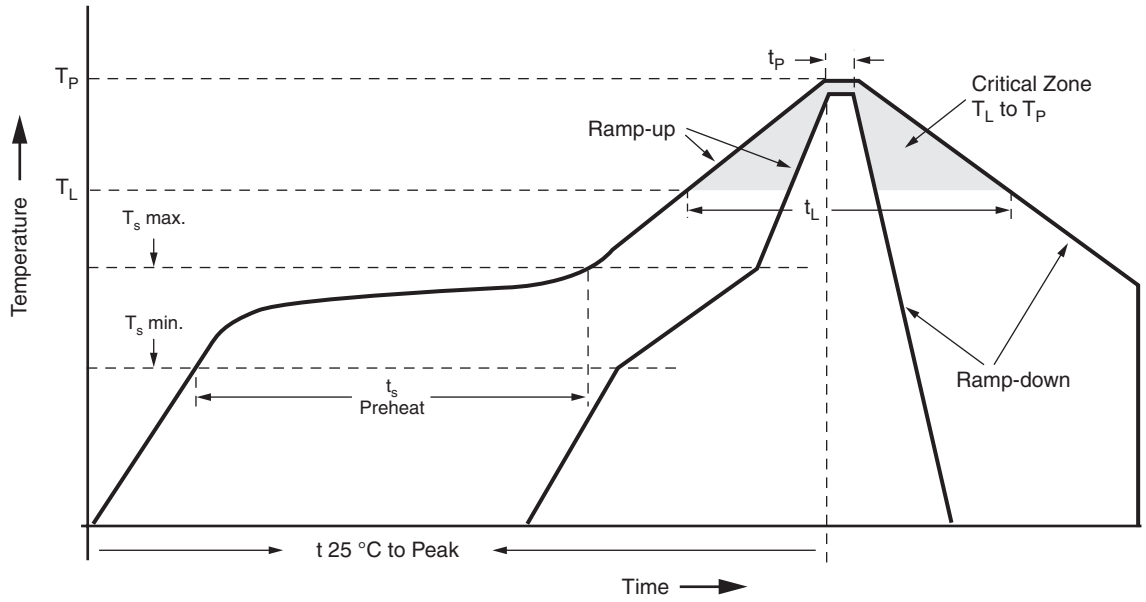
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/85 °C (mA)	WEIGHT (g)	CATALOG NUMBER
6.3	100	5 x 5.3	0.28	3.71	60	0.17	MALSECA00BC310BARK
	330	6.3 x 7.7	0.35	1.41	188	0.40	MALSECA00BM333BARK
	1000	8 x 10	0.35	0.46	370	1.00	MALSECA00AF410BARK
	1500	10 x 10	0.35	0.31	480	1.25	MALSECA00AG415BARK
10	220	8 x 6.2	0.24	1.45	175	0.55	MALSECA00AE322CARK
	470	8 x 10	0.24	0.68	290	1.00	MALSECA00AF347CARK
	1000	10 x 10	0.24	0.32	454	1.25	MALSECA00AG410CARK
	2200	12.5 x 13.5	0.24	0.14	960	2.50	MALSECA00AH422CARK

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/85 °C (mA)	WEIGHT (g)	CATALOG NUMBER
16	47	5 x 5.3	0.20	5.64	52	0.17	MALSECA00BC247DARK
	100	6.3 x 5.3	0.20	2.65	88	0.27	MALSECA00BD310DARK
	220	6.3 x 7.7	0.24	1.45	162	0.40	MALSECA00BM322DARK
	330	8 x 10	0.24	0.96	270	1.00	MALSECA00AF333DARK
	1500	12.5 x 13.5	0.24	0.21	870	2.50	MALSECA00AH415DARK
25	22	5 x 5.3	0.13	7.84	41	0.17	MALSECA00BC222EARK
	33	5 x 5.3	0.13	5.22	50	0.17	MALSECA00BC233EARK
	47	6.3 x 5.3	0.13	3.67	70	0.27	MALSECA00BD247EARK
	100	8 x 6.2	0.16	2.12	145	0.55	MALSECA00AE310EARK
	220	8 x 10	0.16	0.96	232	1.00	MALSECA00AF322EARK
	470	10 x 10	0.16	0.45	400	1.25	MALSECA00AG347EARK
	1000	12.5 x 13.5	0.16	0.21	820	2.50	MALSECA00AH410EARK
35	10	4 x 5.3	0.15	19.9	27	0.12	MALSECA00BB210FARK
	33	6.3 x 5.3	0.15	6.03	65	0.27	MALSECA00BD233FARK
	47	8 x 6.2	0.15	4.23	105	0.55	MALSECA00AE247FARK
	100	8 x 10	0.15	1.99	175	1.00	MALSECA00AF310FARK
	330	10 x 10	0.15	0.60	360	1.25	MALSECA00AG333FARK
	470	12.5 x 13.5	0.15	0.42	600	2.50	MALSECA00AH347FARK
50	0.10	4 x 5.3	0.10	1326	3.2	0.12	MALSECA00BB010HARK
	0.22	4 x 5.3	0.10	602.9	4.7	0.12	MALSECA00BB022HARK
	0.33	4 x 5.3	0.10	401.9	5.7	0.12	MALSECA00BB033HARK
	0.47	4 x 5.3	0.10	282.2	6.8	0.12	MALSECA00BB047HARK
	1.0	4 x 5.3	0.10	132.6	10	0.12	MALSECA00BB110HARK
	2.2	4 x 5.3	0.10	60.3	15	0.12	MALSECA00BB122HARK
	3.3	4 x 5.3	0.10	40.2	18	0.12	MALSECA00BB133HARK
	4.7	5 x 5.3	0.10	28.2	25	0.17	MALSECA00BC147HARK
	10	5 x 5.3	0.10	13.2	41	0.17	MALSECA00BC210HARK
	22	6.3 x 5.3	0.10	6.03	71	0.27	MALSECA00BD222HARK
	33	6.3 x 7.7	0.12	4.82	94	0.40	MALSECA00BM233HARK
	47	8 x 10	0.12	3.39	140	1.00	MALSECA00AF247HARK
	100	10 x 10	0.12	1.59	195	1.25	MALSECA00AG310HARK
	220	10 x 10	0.12	0.72	320	1.25	MALSECA00AG322HARK
	330	12.5 x 13.5	0.12	0.48	600	2.50	MALSECA00AH333HARK
63	10	6.3 x 5.8	0.12	15.9	46	0.30	MALSECA00AD210JARK
	22	8 x 6.2	0.12	7.23	96	0.55	MALSECA00AE222JARK
	33	8 x 10	0.12	4.82	117	1.00	MALSECA00AF233JARK
	220	12.5 x 13.5	0.12	0.72	550	2.50	MALSECA00AH322JARK
100	2.2	5 x 5.3	0.12	72.35	20	0.17	MALSECA00BC122LARK
	3.3	6.3 x 5.8	0.12	48.2	29	0.30	MALSECA00AD133LARK
	4.7	6.3 x 5.8	0.12	33.9	35	0.30	MALSECA00AD147LARK
	10	8 x 10	0.12	15.9	77	1.00	MALSECA00AF210LARK
	22	8 x 10	0.12	7.23	100	1.00	MALSECA00AF222LARK
	33	10 x 10	0.12	4.82	130	1.25	MALSECA00AG233LARK
	47	10 x 10	0.12	3.39	155	1.25	MALSECA00AG247LARK
	68	12.5 x 13.5	0.12	2.34	350	2.50	MALSECA00AH268LARK
	100	12.5 x 13.5	0.12	1.59	420	2.50	MALSECA00AH310LARK

REFLOW SOLDERING CONDITIONS FOR SMD ALUMINUM ELECTROLYTIC CAPACITORS



PROFILE FEATURE			
	SOLDERING CONDITION		
	Ø 4 ~ Ø 10	Ø 12.5	Ø 16
Average ramp-up rate (T_L to $T_{P)}$	3 °C/s max.	3 °C/s max.	
Preheat			
Temperature min. (T_s min.)	150 °C	150 °C	
Temperature max. (T_s max.)	200 °C	200 °C	
Time (T_s min. to T_s max.)	60 ~ 150 s	40 ~ 120 s	40 ~ 100 s
T_s max. to T_L			
Ramp-up rate	3 °C/s max.	3 °C/s max.	
Time maintained above			
Temperature (T_L)	217 °C	217 °C	
Time (t_L)	60 ~ 90 s	40 ~ 60 s	
Peak/classification temperature (T_P)	250 °C	240 °C	230 °C
Time within 5 °C of actual peak temperature (T_P)	10 s max.	10 s max.	
Ramp-down rate	3 °C/s max.	3 °C/s max.	
Time 25 °C to peak temperature	8 min max.	8 min max.	

RESISTANCE TO SOLDERING HEAT	
Leakage current	Less than specified value
Capacitance value	Within ± 10 % of initial value
tan δ	Less than specified value

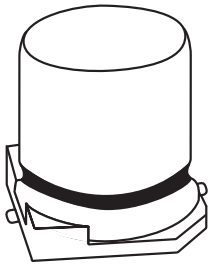
LOW TEMPERATURE BEHAVIOR (at 120 Hz)								
IMPEDANCE RATIO (Z) T2/(Z) T1	**RATED VOLTAGE (V)**							
T2/T1	**6.3**	**10**	**16**	**25**	**35**	**50**	**63**	**100**
- 25 °C/+ 20 °C	5	4	3	2	2	2	2	2
- 40 °C/+ 20 °C	10	8	6	4	3	3	3	3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA for $U_R \leq 100$ V (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta/2 \pi f C_R$

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER FOR $U_R \leq 100$ V**
50	0.70
120	1.00
300	1.17
1000	1.36
≥ 10 000	1.50

TEST PROCEDURES AND REQUIREMENTS		
TEST	**PROCEDURE (QUICK REFERENCE)**	**REQUIREMENTS**
Load life	T_{amb} = 85 °C U_R and I_R applied After 2000 h	ΔC/C: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit
Shelf life	No voltage applied After 1000 h After test: U_R to be applied for 30 min 24 to 48 h before measurement	ΔC/C: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit

Aluminum Capacitors



FEATURES

- Polarized aluminum electrolytic capacitors
- SMD style
- Miniature dimension
- Extended temperature range: 105 °C
- Reflow soldering
- RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Industrial electronics, automotive electronics, telecommunication systems
- Smoothing and filtering
- Miniature power supply units, dc-to-dc converters

PACKAGING

- Supplied in blister tape

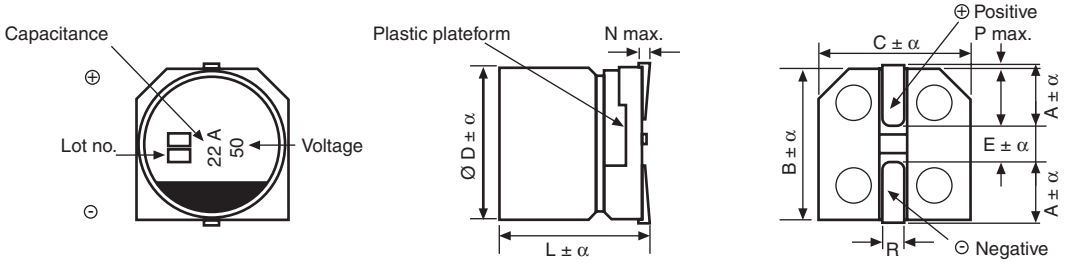
QUICK REFERENCE DATA		
DESCRIPTION	**UNIT**	**VALUE**
Nominal case size (Ø D x L)	mm	6.3 x 5.8 to 16 x 16.5
Rated capacitance range C_R	µF	10 to 2200
Capacitance tolerance	%	± 20
Rated voltage range	V	6.3 to 100
Category temperature range	°C	- 40 to 105
Load life	h	2000
Based on sectional specification		IEC 60384-4/ EN130300
Climatic category IEC 60068		40/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	RATED VOLTAGE (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
10	→	→	4 x 5.3	→	5 x 5.3	6.3 x 5.8
22	→	→	→	6.3 x 5.8	6.3 x 5.8	8 x 6.2
33	→	→	6.3 x 5.8	6.3 x 5.8	8 x 6.2	8 x 10
47	5 x 5.3	→	6.3 x 5.8	8 x 6.2	8 x 10	10 x 10
100	→	6.3 x 5.8	→	8 x 10	→	10 x 10
220	→	8 x 10	10 x 10	→	10 x 10	12.5 x 13.5
330	8 x 10	→	10 x 10	10 x 10	12.5 x 13.5	-
470	→	10 x 10	10 x 10	10 x 10	12.5 x 13.5	-
680	→	→	→	12.5 x 13.5	-	-
1000	→	10 x 10	12.5 x 13.5	-	-	-
1500	10 x 10	12.5 x 13.5	-	-	-	-
2200	12.5 x 13.5	-	-	-	-	-

DIMENSIONS in millimeters

CASE SIZE CODE	D ± α	L ± α	A ± α	B ± α	C ± α	E ± α	R	N	P
AD	6.3 ± 0.5	5.8 ± 0.3	2.4 ± 0.2	6.6 ± 0.2	6.6 ± 0.2	2.2 ± 0.2	0.5 ~ 0.8	0.3	0.5
BM	6.3 ± 0.5	7.7 ± 0.4	2.4 ± 0.2	6.6 ± 0.2	6.6 ± 0.2	2.2 ± 0.2	0.5 ~ 0.8	0.3	0.5
AE	8 ± 0.5	6.2 ± 0.4	3.3 ± 0.2	8.3 ± 0.2	8.3 ± 0.2	2.3 ± 0.2	0.5 ~ 0.8	0.3	0.5
AF	8 ± 0.5	10 ± 0.5	2.9 ± 0.2	8.3 ± 0.2	8.3 ± 0.2	3.1 ± 0.2	0.8 ~ 1.1	0.3	0.5
AG	10 ± 0.5	10 ± 0.5	3.2 ± 0.2	10.3 ± 0.2	10.3 ± 0.2	4.5 ± 0.2	0.8 ~ 1.1	0.3	0.5
AH	12.5 ± 0.5	13.5 ± 0.5	4.6 ± 0.2	12.8 ± 0.2	12.8 ± 0.2	4.5 ± 0.2	1.1 ~ 1.4	0.3	0.5
AK	16 ± 0.5	16.5 ± 0.5	5.6 ± 0.2	16.8 ± 0.2	16.8 ± 0.2	6.5 ± 0.2	1.1 ~ 1.4	0.3	0.5



ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	max. equivalent series resistance at 120 Hz
I_R	rated alternating current at 120 Hz and upper catagory temperature

Note

Unless otherwise specified, all electrical values apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

ECV 220 µF/35 V, ± 20 %, size 10 x 10 mm

Ordering code: MALSECV00AG322FARK

For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service.

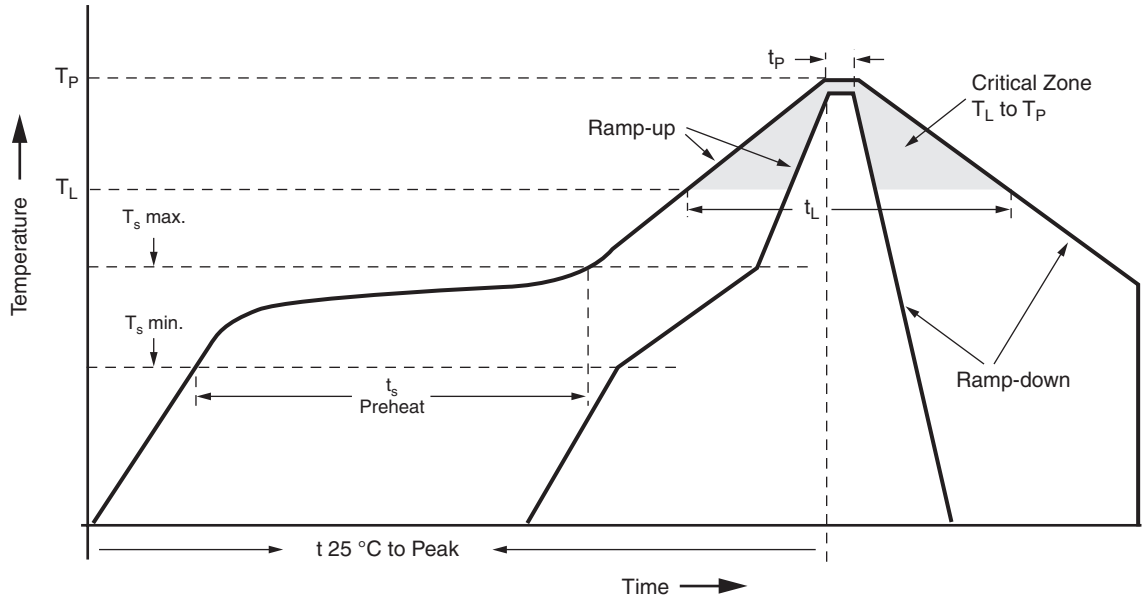
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz/20 °C (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER
6.3	47	5 x 5.3	0.22	6.21	36	0.17	MALSECV00BC247BARK
	330	8 x 10	0.28	1.13	288	1.00	MALSECV00AF333BARK
	1500	10 x 10	0.28	0.25	560	1.21	MALSECV00AG415BARK
	2200	12.5 x 13.5	0.28	0.17	730	2.00	MALSECV00AH422BARK
10	100	6.3 x 5.8	0.19	2.52	60	0.30	MALSECV00AD310CARK
	220	8 x 10	0.24	1.45	173	1.00	MALSECV00AF322CARK
	470	10 x 10	0.24	0.68	351	1.21	MALSECV00AG347CARK
	1000	10 x 10	0.24	0.32	550	1.21	MALSECV00AG410CARK
	1500	12.5 x 13.5	0.24	0.21	650	2.00	MALSECV00AH415CARK
16	10	4 x 5.3	0.16	21.22	17	0.12	MALSECV00BB210DARK
	33	6.3 x 5.8	0.16	6.43	40	0.30	MALSECV00AD233DARK
	47	6.3 x 5.8	0.16	4.52	50	0.30	MALSECV00AD247DARK
	220	10 x 10	0.20	1.21	330	1.21	MALSECV00AG322DARK
	330	10 x 10	0.20	0.80	441	1.21	MALSECV00AG333DARK
	470	10 x 10	0.20	0.56	489	1.21	MALSECV00AG347DARK
	1000	12.5 x 13.5	0.20	0.27	600	2.00	MALSECV00AH410DARK

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz/20 °C (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER
25	22	6.3 x 5.8	0.14	8.44	38	0.30	MALSECV00AD222EARK
	33	6.3 x 5.8	0.14	5.63	48	0.30	MALSECV00AD233EARK
	47	8 x 6.2	0.16	4.52	79	0.55	MALSECV00AE247EARK
	100	8 x 10	0.16	2.12	181	1.00	MALSECV00AF310EARK
	330	10 x 10	0.16	0.64	372	1.21	MALSECV00AG333EARK
	470	10 x 10	0.16	0.45	450	1.21	MALSECV00AG347EARK
	680	12.5 x 13.5	0.16	0.31	500	2.00	MALSECV00AH368EARK
35	10	5 x 5.3	0.12	15.92	24	0.17	MALSECV00BC210FARK
	22	6.3 x 5.8	0.12	7.23	42	0.30	MALSECV00AD222FARK
	33	8 x 6.2	0.13	5.22	76	0.55	MALSECV00AE233FARK
	47	8 x 10	0.13	3.67	124	1.00	MALSECV00AF247FARK
	220	10 x 10	0.13	0.78	450	1.21	MALSECV00AG322FARK
	330	12.5 x 13.5	0.13	0.52	500	2.00	MALSECV00AH333FARK
	470	12.5 x 13.5	0.13	0.37	600	2.00	MALSECV00AH347FARK
50	10	6.3 x 5.8	0.10	13.26	30	0.30	MALSECV00AD210HARK
	22	8 x 6.2	0.12	7.23	67	0.55	MALSECV00AE222HARK
	33	8 x 10	0.12	4.82	133	1.00	MALSECV00AF233HARK
	47	10 x 10	0.12	3.39	180	1.21	MALSECV00AG247HARK
	100	10 x 10	0.12	1.59	310	1.21	MALSECV00AG310HARK
	220	12.5 x 13.5	0.12	0.72	480	2.00	MALSECV00AH322HARK

REFLOW SOLDERING CONDITIONS FOR SMD ALUMINUM ELECTROLYTIC CAPACITORS



PROFILE FEATURE

	SOLDERING CONDITION		
	Ø 4 ~ Ø 10	Ø 12.5	Ø 16
Average ramp-up rate (T_L to T_P)	3 °C/s max.	3 °C/s max.	
Preheat			
Temperature min. (T_s min.)	150 °C	150 °C	
Temperature max. (T_s max.)	200 °C	200 °C	
Time (T_s min. to T_s max.)	60 ~ 150 s	40 ~ 120 s	40 ~ 100 s
T_s max. to T_L			
Ramp-up rate	3 °C/s max.	3 °C/s max.	

PROFILE FEATURE			
Time maintained above Temperature (T_L)	217 °C	217 °C	
Time (t_L)	60 ~ 90 s	40 ~ 60 s	
Peak/classification temperature (T_P)	250 °C	240 °C	230 °C
Time within 5 °C of actual peak temperature (T_P)	10 s max.	10 s max.	
Ramp-down rate	3 °C/s max.	3 °C/s max.	
Time 25 °C to peak temperature	8 min max.	8 min max.	

RESISTANCE TO SOLDERING HEAT	
Leakage current	Less than specified value
Capacitance value	Within ± 10 % of initial value
tan δ	Less than specified value

LOW TEMPERATURE BEHAVIOR (at 120 Hz)

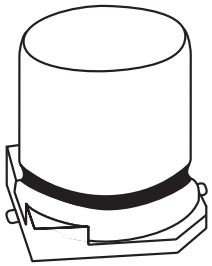
IMPEDANCE RATIO (Z) T2/(Z) T1	RATED VOLTAGE (V)							
T2/T1	**6.3**	**10**	**16**	**25**	**35**	**50**	**63**	**100**
- 25 °C/+ 20 °C	3	3	2	2	2	2	3	3
- 40 °C/+ 20 °C	8	5	4	3	3	3	4	4

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA for $U_R \leq 100$ V (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta / 2 \pi f C_R$

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER FOR $U_R \leq 100$ V**
50	0.70
120	1.00
300	1.17
1000	1.36
≥ 10 000	1.50

TEST PROCEDURES AND REQUIREMENTS		
TEST	**PROCEDURE (QUICK REFERENCE)**	**REQUIREMENTS**
Load life	T_{amb} = 105 °C U_R and I_R applied After 2000 h	$\Delta C/C$: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2 \times$ spec. limit
Shelf life	No voltage applied After 1000 h After test: U_R to be applied for 30 min 24 to 48 h before measurement	$\Delta C/C$: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2 \times$ spec. limit

Aluminum Capacitors



FEATURES

- Polarized aluminum electrolytic capacitors, non solid electrolyte
- Extra low impedance, high ripple current
- Temperature up to 105 °C
- RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- SMD technology, for high mounting density
- Industrial and professional applications
- General industrial, consumer
- Smoothing, filtering, buffering

PACKAGING

- Supplied in blister tape

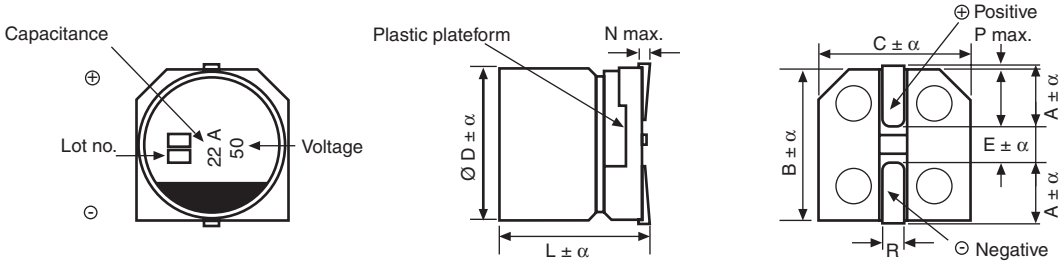
QUICK REFERENCE DATA		
DESCRIPTION	**UNIT**	**VALUE**
Nominal case size (Ø D x L)	mm	6 x 5.8 to 12.5 x 13.5
Rated capacitance range C_R	µF	10 to 1500
Capacitance tolerance	%	± 20
Rated voltage range	V	6.3 to 100
Category temperature range	°C	- 40 to 105
Load life	h	2000
Based on sectional specification		IEC 60384-4/ EN 130300
Climatic category IEC 60068		40/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	RATED VOLTAGE (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
10	→	→	→	→	→	6.3 x 5.8
22	→	→	→	→	→	6.3 x 5.8
33	→	→	→	→	6.3 x 5.8	8 x 6.2
47	→	→	→	→	6.3 x 5.8	8 x 6.2
68	→	→	→	6.3 x 5.8	8 x 6.2	8 x 10
100	→	→	6.3 x 5.8	8 x 6.2	8 x 10	10 x 10
220	6.3 x 5.8	6.3 x 7.7	8 x 6.2	8 x 10	10 x 10	-
330	8 x 6.2	→	8 x 10	-	-	-
470	→	8 x 10	10 x 10	-	-	-
680	→	10 x 10	-	-	-	-
1000	10 x 10	-	-	-	-	-
1500	10 x 10	-	-	-	-	-

DIMENSIONS in millimeters

CASE SIZE CODE	D ± α	L ± α	A ± α	B ± α	C ± α	E ± α	R	N	P
AD	6.3 ± 0.5	5.8 ± 0.3	2.4 ± 0.2	6.6 ± 0.2	6.6 ± 0.2	2.2 ± 0.2	0.5 ~ 0.8	0.3	0.5
BM	6.3 ± 0.5	7.7 ± 0.4	2.4 ± 0.2	6.6 ± 0.2	6.6 ± 0.2	2.2 ± 0.2	0.5 ~ 0.8	0.3	0.5
AE	8 ± 0.5	6.2 ± 0.4	3.3 ± 0.2	8.3 ± 0.2	8.3 ± 0.2	2.3 ± 0.2	0.5 ~ 0.8	0.3	0.5
AF	8 ± 0.5	10 ± 0.5	2.9 ± 0.2	8.3 ± 0.2	8.3 ± 0.2	3.1 ± 0.2	0.8 ~ 1.1	0.3	0.5
AG	10 ± 0.5	10 ± 0.5	3.2 ± 0.2	10.3 ± 0.2	10.3 ± 0.2	4.5 ± 0.2	0.8 ~ 1.1	0.3	0.5
AH	12.5 ± 0.5	13.5 ± 0.5	4.6 ± 0.2	12.8 ± 0.2	12.8 ± 0.2	4.5 ± 0.2	1.1 ~ 1.4	0.3	0.5



ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	max. equivalent series resistance at 120 Hz
I_R	rated alternating current at 120 Hz and upper catagory temperature
Z	max. impedance at 100 kHz

Note

Unless otherwise specified, all electrical values apply at T_{amb} = 20 °C, P = 86 to 100 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

ECL 22 µF/50 V, ± 20 %, size 6.3 x 5.8 mm

Ordering code: MALSECL00AD222HARK

For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service.

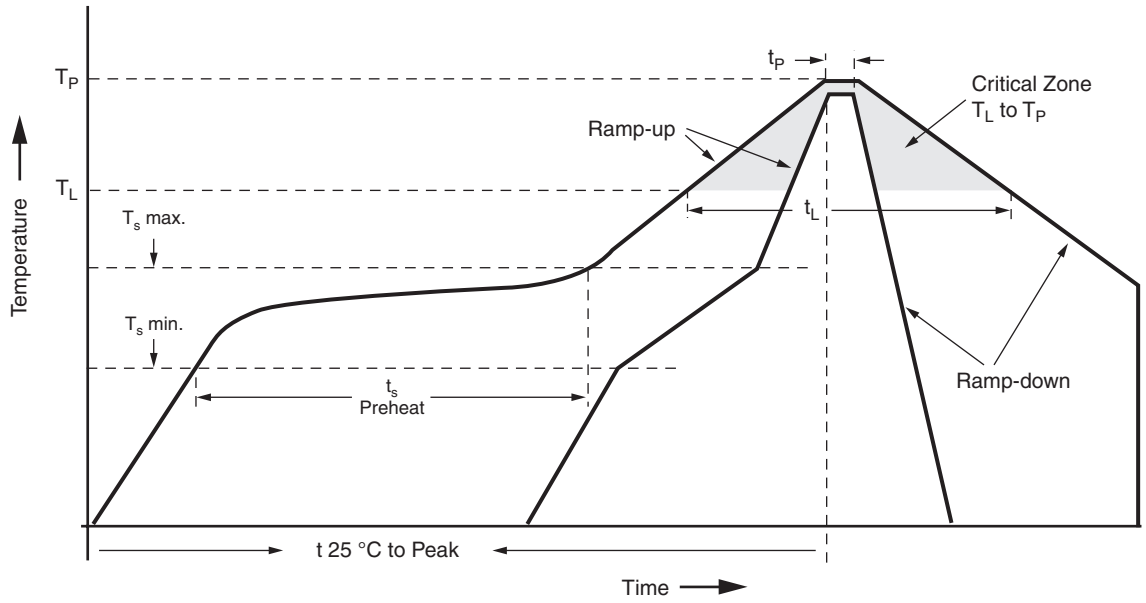
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	Z 100 kHz/ 20 °C (Ω)	I_R 100 kHz/ 105 °C (mA)	WEIGHT (g)	CATALOG NUMBER
6.3	220	6.3 x 5.8	0.24	0.44	230	0.30	MALSECL00AD322BARK
	330	8 x 6.2	0.24	0.26	300	0.55	MALSECL00AE333BARK
	1000	10 x 10	0.24	0.09	670	1.21	MALSECL00AG410BARK
	1500	10 x 10	0.24	0.09	670	1.21	MALSECL00AG415BARK
10	220	6.3 x 7.7	0.19	0.34	280	0.40	MALSECL00BM322CARK
	470	8 x 10	0.19	0.17	450	1.00	MALSECL00AF347CARK
	680	10 x 10	0.19	0.09	670	1.21	MALSECL00AG368CARK
16	100	6.3 x 5.8	0.16	0.44	230	0.30	MALSECL00AD310DARK
	220	8 x 6.2	0.16	0.26	300	0.55	MALSECL00AE322DARK
	330	8 x 10	0.16	0.17	450	1.00	MALSECL00AF333DARK
	470	10 x 10	0.16	0.09	670	1.21	MALSECL00AG347DARK
25	68	6.3 x 5.8	0.14	0.44	230	0.30	MALSECL00AD268EARK
	100	8 x 6.2	0.14	0.26	300	0.55	MALSECL00AE310EARK
	220	8 x 10	0.14	0.17	450	1.00	MALSECL00AF322EARK

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	Z 100 kHz/ 20 °C (Ω)	I_R 100 kHz/ 105 °C (mA)	WEIGHT (g)	CATALOG NUMBER
35	33	6.3 x 5.8	0.12	0.44	230	0.30	MALSECL00AD233FARK
	47	6.3 x 5.8	0.12	0.44	230	0.30	MALSECL00AD247FARK
	68	8 x 6.2	0.12	0.26	300	0.55	MALSECL00AE268FARK
	100	8 x 10	0.12	0.17	450	1.00	MALSECL00AF310FARK
	220	10 x 10	0.12	0.09	670	1.21	MALSECL00AG322FARK
50	10	6.3 x 5.8	0.12	0.88	165	0.30	MALSECL00AD210HARK
	22	6.3 x 5.8	0.12	0.88	165	0.30	MALSECL00AD222HARK
	33	8 x 6.2	0.12	0.63	300	0.55	MALSECL00AE233HARK
	47	8 x 6.2	0.12	0.63	300	0.55	MALSECL00AE247HARK
	68	8 x 10	0.12	0.34	450	1.00	MALSECL00AF268HARK
	100	10 x 10	0.12	0.18	670	1.21	MALSECL00AG310HARK

REFLOW SOLDERING CONDITIONS FOR SMD ALUMINUM ELECTROLYTIC CAPACITORS



PROFILE FEATURE	SOLDERING CONDITION		
	Ø 4 ~ Ø 10	Ø 12.5	Ø 16
Average ramp-up rate (T_L to $T_{P)}$	3 °C/s max.	3 °C/s max.	
Preheat			
Temperature min. (T_s min.)	150 °C	150 °C	
Temperature max. (T_s max.)	200 °C	200 °C	
Time (T_s min. to T_s max.)	60 ~ 150 s	40 ~ 120 s	40 ~ 100 s
T_s max. to T_L			
Ramp-up rate	3 °C/s max.	3 °C/s max.	
Time maintained above			
Temperature (T_L)	217 °C	217 °C	
Time (t_L)	60 ~ 90 s	40 ~ 60 s	

PROFILE FEATURE			
Peak/classification temperature (T_P)	250 °C	240 °C	230 °C
Time within 5 °C of actual peak temperature (T_P)	10 s max.	10 s max.	
Ramp-down rate	3 °C/s max.	3 °C/s max.	
Time 25 °C to peak temperature	8 min max.	8 min max.	

RESISTANCE TO SOLDERING HEAT	
Leakage current	Less than specified value
Capacitance value	Within ± 10 % of initial value
tan δ	Less than specified value

LOW TEMPERATURE BEHAVIOR (at 120 Hz)

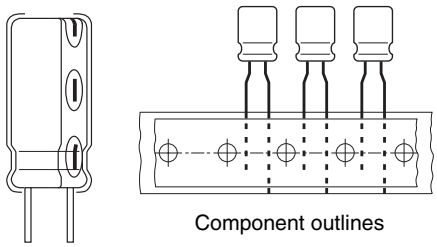
IMPEDANCE RATIO (Z) T2/(Z) T1	RATED VOLTAGE (V)							
T2/T1	**6.3**	**10**	**16**	**25**	**35**	**50**	**63**	**100**
- 25 °C/+ 20 °C	2	2	2	2	2	2	3	3
- 40 °C/+ 20 °C	3	3	3	3	3	3	4	4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER**
50	0.41
120	0.59
300	0.69
1000	0.80
10 000	0.88
100 000	1.00

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA for $U_R \leq 100$ V (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta / 2 \pi f C_R$

TEST PROCEDURES AND REQUIREMENTS		
TEST	**PROCEDURE (QUICK REFERENCE)**	**REQUIREMENTS**
Load life	T_{amb} = 105 °C U_R and I_R applied After 2000 h	ΔC/C: ± 25 % of initial value $I_L \leq$ spec. limit tan $\delta \leq$ 2 x spec. limit
Shelf life	No voltage applied After 1000 h After test: U_R to be applied for 30 min 24 to 48 h before measurement	ΔC/C: ± 25 % of initial value $I_L \leq$ spec. limit tan $\delta \leq$ 2 x spec. limit

Aluminum Capacitors
Radial Style



Component outlines

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case
- Miniaturized, high CV-product per unit volume
- RoHS compliant

Pb-free
RoHS COMPLIANT

APPLICATIONS

- General purpose, industrial and audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Portable and mobile equipment (small size, low mass)

QUICK REFERENCE DATA

DESCRIPTION	UNIT	VALUE	
Nominal case size (Ø D x L)	mm	5 x 11 to 18 x 40	
Rated capacitance range C_R	µF	1 to 22 000	
Capacitance tolerance	%	± 20	
Rated voltage range	V	6.3 to 350	400 to 450
Category temperature range	°C	- 40 to + 85	- 25 to + 85
Load life	h	2000	
Based on sectional specification		IEC 60384-4/EN 130300	
Climatic category IEC 60068		40/085/56	25/085/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	RATED VOLTAGE (V) (> 100 V see next page)							
	6.3	10	16	25	35	50	63	100
1.0	→	→	→	→	→	→	5 x 11	5 x 11
1.5	→	→	→	→	→	→	5 x 11	5 x 11
2.2	→	→	→	→	→	→	5 x 11	5 x 11
3.3	→	→	→	→	→	→	5 x 11	5 x 11
4.7	→	→	→	→	→	→	5 x 11	5 x 11
6.8	→	→	→	→	→	→	5 x 11	5 x 11
10	→	→	→	→	→	→	5 x 11	5 x 11
15	→	→	→	→	→	→	5 x 11	6.3 x 11
22	→	→	→	→	→	→	5 x 11	6.3 x 11
33	→	→	→	→	→	5 x 11	6.3 x 11	8 x 11.5
47	→	→	→	→	5 x 11	→	6.3 x 11	8 x 11.5
68	→	→	→	5 x 11	→	6.3 x 11	8 x 11.5	10 x 12.5
100	→	→	→	5 x 11	6.3 x 11	→	8 x 11.5	10 x 16
150	→	→	5 x 11	6.3 x 11	8 x 11.5	→	10 x 12.5	10 x 20
220	→	5 x 11	→	6.3 x 11	8 x 11.5	10 x 12.5	10 x 16	12.5 x 20
330	→	→	6.3 x 11	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 25
470	→	6.3 x 11	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	16 x 25
680	→	→	8 x 11.5	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 31.5
1000	8 x 11.5	→	10 x 12.5	10 x 16	12.5 x 20	12.5 x 25	16 x 25	18 x 31.5
2200	→	10 x 16	10 x 20	12.5 x 20	16 x 25	16 x 31.5	18 x 31.5	-
3300	10 x 20	→	12.5 x 20	16 x 25	16 x 31.5	18 x 31.5	18 x 40	-
4700	12.5 x 20	→	12.5 x 25	16 x 25	16 x 35.5	18 x 40	-	-
6800	12.5 x 25	→	16 x 25	18 x 31.5	18 x 40	-	-	-
10 000	16 x 25	→	16 x 31.5	18 x 40	-	-	-	-
15 000	→	16 x 35.5	18 x 35.5	-	-	-	-	-
22 000	→	18 x 40	-	-	-	-	-	-

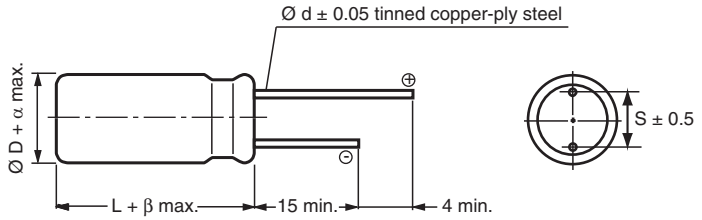
Note
10 % capacitance tolerance on request

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	RATED VOLTAGE (V)					
	160	200	250	350	400	450
1.0	→	→	→	→	→	8 x 11.5
1.5	→	→	→	→	→	8 x 11.5
2.2	→	→	→	→	→	8 x 11.5
3.3	6.3 x 11	→	6.3 x 11	→	→	8 x 11.5
4.7	6.3 x 11	→	6.3 x 11	8 x 11.5	→	10 x 12.5
6.8	8 x 11.5	→	8 x 11.5	→	10 x 12.5	10 x 16
10	→	8 x 11.5	→	10 x 12.5	10 x 16	10 x 20
15	10 x 12.5	→	10 x 16	10 x 20	→	12.5 x 20
22	10 x 12.5	→	10 x 16	→	12.5 x 20	12.5 x 25
33	10 x 16	→	10 x 20	→	12.5 x 25	16 x 25
47	→	10 x 20	12.5 x 20	16 x 20	16 x 25	16 x 31.5
68	12.5 x 20	12.5 x 25	16 x 20	16 x 25	16 x 31.5	16 x 35.5
100	12.5 x 25	→	16 x 25	18 x 31.5	18 x 35.5	18 x 40
150	16 x 20	16 x 25	16 x 31.5	→	18 x 40	-
220	16 x 25	18 x 31.5	18 x 35.5	-	-	-
330	16 x 35.5	18 x 35.5	-	-	-	-
470	18 x 40	-	-	-	-	-

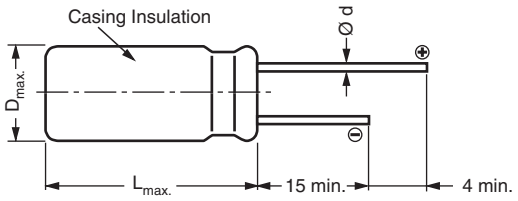
Note
10 % capacitance tolerance on request

RADIAL STYLE: DIMENSIONS in millimeters

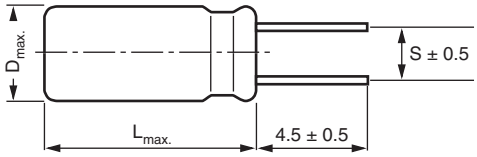


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

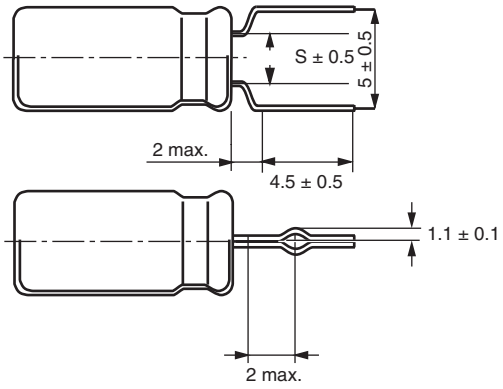
DIMENSIONS in millimeters AND AVAILABLE FORMS



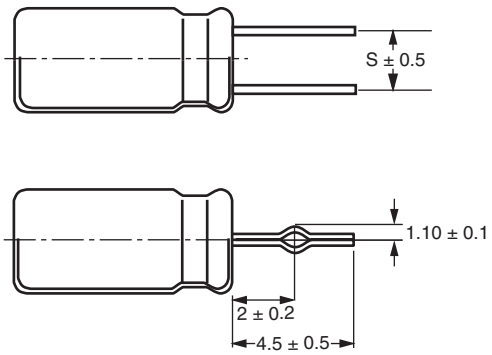
Ø D ≤ 18 long leads MALREKA00...



Ø D ≤ 18 shortened leads MALREKA05...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKA09...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKA06...
(S = 5/7.5 mm)

GENERAL NOTE

- For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service
- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	calculated equivalent series resistance at 120 Hz
I_R	rated ripple current (rms) at 120 Hz and upper category temperature

Note
Unless otherwise specified, all electrical values apply at T_a = 20 °C, P = 80 to 120 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

EKA 3300 µF/16 V, ± 20 %, size: 12.5 x 20 mm
Leads: Long
Ordering code: MALREKA00FE433D00K

Leads: Short
Ordering code: MALREKA05...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKA09...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKA06 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/85 °C (mA)	WEIGHT (g)	CATALOG NUMBER (LONG LEADS)
6.3	1000	8 x 11.5	0.28	0.37	581	1.20	MALREKA00PB410B00K
	3300	10 x 20	0.34	0.14	1286	2.80	MALREKA00DE433B00K
	4700	12.5 x 20	0.36	0.10	1736	4.10	MALREKA00FE447B00K
	6800	12.5 x 25	0.40	0.08	2129	5.60	MALREKA00FG468B00K
	10 000	16 x 25	0.46	0.06	2629	7.50	MALREKA00JG510B00K
10	220	5 x 11	0.24	1.45	218	0.45	MALREKA00AA322C00K
	470	6.3 x 11	0.24	0.68	366	0.48	MALREKA00BA347C00K
	2200	10 x 16	0.28	0.17	1051	2.30	MALREKA00DD422C00K
	15 000	16 x 35.5	0.52	0.05	3284	10.5	MALREKA00JL515C00K
	22 000	18 x 40	0.70	0.04	3843	16.0	MALREKA00KK522C00K
16	150	5 x 11	0.20	1.77	198	0.45	MALREKA00AA315D00K
	330	6.3 x 11	0.20	0.80	359	0.48	MALREKA00BA333D00K
	470	8 x 11.5	0.20	0.56	476	1.20	MALREKA00PB347D00K
	680	8 x 11.5	0.20	0.39	600	1.20	MALREKA00PB368D00K
	1000	10 x 12.5	0.20	0.27	796	1.85	MALREKA00DC410D00K
	2200	10 x 20	0.24	0.14	1331	2.80	MALREKA00DE422D00K
	3300	12.5 x 20	0.26	0.10	1686	4.10	MALREKA00FE433D00K
	4700	12.5 x 25	0.28	0.08	2129	5.60	MALREKA00FG447D00K
	6800	16 x 25	0.32	0.06	2577	7.50	MALREKA00JG468D00K
	10 000	16 x 31.5	0.38	0.05	3176	9.50	MALREKA00JS510D00K
	15 000	18 x 35.5	0.48	0.04	3656	13.0	MALREKA00KL515D00K
25	68	5 x 11	0.16	3.12	144	0.45	MALREKA00AA268E00K
	100	5 x 11	0.16	2.12	181	0.45	MALREKA00AA310E00K
	150	6.3 x 11	0.16	1.42	246	0.48	MALREKA00BA315E00K
	220	6.3 x 11	0.16	0.97	327	0.48	MALREKA00BA322E00K
	330	8 x 11.5	0.16	0.64	431	1.20	MALREKA00PB333E00K
	470	10 x 12.5	0.16	0.45	550	1.85	MALREKA00DC347E00K
	680	10 x 16	0.16	0.31	754	2.30	MALREKA00DD368E00K
	1000	10 x 16	0.16	0.21	942	2.30	MALREKA00DD410E00K
	2200	12.5 x 20	0.20	0.12	1542	4.10	MALREKA00FE422E00K
	3300	16 x 25	0.22	0.09	2194	7.50	MALREKA00JG433E00K
	4700	16 x 25	0.24	0.07	2448	7.50	MALREKA00JG447E00K
	6800	18 x 31.5	0.28	0.05	3114	12.0	MALREKA00KS468E00K
	10 000	18 x 40	0.34	0.05	3544	16.0	MALREKA00KK510E00K
35	47	5 x 11	0.14	3.95	131	0.45	MALREKA00AA247F00K
	100	6.3 x 11	0.14	1.86	220	0.48	MALREKA00BA310F00K
	150	8 x 11.5	0.14	1.24	318	1.20	MALREKA00PB315F00K
	220	8 x 11.5	0.14	0.84	386	1.20	MALREKA00PB322F00K
	330	10 x 12.5	0.14	0.56	549	1.85	MALREKA00DC333F00K
	470	10 x 16	0.14	0.40	740	2.30	MALREKA00DD347F00K
	680	10 x 20	0.14	0.27	947	2.80	MALREKA00DE368F00K
	1000	12.5 x 20	0.14	0.19	1306	4.10	MALREKA00FE410F00K
	2200	16 x 25	0.18	0.11	2032	7.50	MALREKA00JG422F00K
	3300	16 x 31.5	0.20	0.08	2502	9.50	MALREKA00JS433F00K
	4700	16 x 35.5	0.22	0.06	2905	10.5	MALREKA00JL447F00K
	6800	18 x 40	0.26	0.05	3408	16.0	MALREKA00KK468F00K
50	33	5 x 11	0.12	4.83	123	0.45	MALREKA00AA233H00K
	68	6.3 x 11	0.12	2.34	203	0.48	MALREKA00BA268H00K
	220	10 x 12.5	0.12	0.72	501	1.85	MALREKA00DC322H00K
	330	10 x 16	0.12	0.48	672	2.30	MALREKA00DD333H00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/85 °C (mA)	WEIGHT (g)	CATALOG NUMBER (LONG LEADS)
50	470	10 x 20	0.12	0.34	875	2.80	MALREKA00DE347H00K
	680	12.5 x 20	0.12	0.23	1235	4.10	MALREKA00FE368H00K
	1000	12.5 x 25	0.12	0.16	1633	5.60	MALREKA00FG410H00K
	2200	16 x 31.5	0.16	0.10	2220	9.50	MALREKA00JS422H00K
	3300	18 x 31.5	0.18	0.07	2765	12.0	MALREKA00KS433H00K
	4700	18 x 40	0.20	0.06	3272	16.0	MALREKA00KK447H00K
63	1.0	5 x 11	0.10	133	23	0.45	MALREKA00AA110J00K
	1.5	5 x 11	0.10	88.5	28	0.45	MALREKA00AA115J00K
	2.2	5 x 11	0.10	60.3	34	0.45	MALREKA00AA122J00K
	3.3	5 x 11	0.10	40.2	42	0.45	MALREKA00AA133J00K
	4.7	5 x 11	0.10	28.2	50	0.45	MALREKA00AA147J00K
	6.8	5 x 11	0.10	19.5	60	0.45	MALREKA00AA168J00K
	10	5 x 11	0.10	13.3	72	0.45	MALREKA00AA210J00K
	15	5 x 11	0.10	8.85	89	0.45	MALREKA00AA215J00K
	22	5 x 11	0.10	6.03	108	0.45	MALREKA00AA222J00K
	33	6.3 x 11	0.10	4.02	151	0.48	MALREKA00BA233J00K
	47	6.3 x 11	0.10	2.82	181	0.48	MALREKA00BA247J00K
	68	8 x 11.5	0.10	1.95	256	1.20	MALREKA00PB268J00K
	100	8 x 11.5	0.10	1.33	311	1.20	MALREKA00PB310J00K
	150	10 x 12.5	0.10	0.88	422	1.85	MALREKA00DC315J00K
	220	10 x 16	0.10	0.60	586	2.30	MALREKA00DD322J00K
	330	10 x 20	0.10	0.40	784	2.80	MALREKA00DE333J00K
	470	12.5 x 20	0.10	0.28	1098	4.10	MALREKA00FE347J00K
	680	12.5 x 25	0.10	0.20	1440	5.60	MALREKA00FG368J00K
	1000	16 x 25	0.10	0.13	1937	7.50	MALREKA00JG410J00K
	2200	18 x 31.5	0.14	0.08	2445	12.0	MALREKA00KS422J00K
	3300	18 x 40	0.16	0.06	2987	16.0	MALREKA00KK433J00K
100	1.0	5 x 11	0.08	106	23	0.45	MALREKA00AA110L00K
	1.5	5 x 11	0.08	70.8	28	0.45	MALREKA00AA115L00K
	2.2	5 x 11	0.08	48.3	34	0.45	MALREKA00AA122L00K
	3.3	5 x 11	0.08	32.2	42	0.45	MALREKA00AA133L00K
	4.7	‘5 x 11	0.08	22.6	50	0.45	MALREKA00AA147L00K
	6.8	5 x 11	0.08	15.6	60	0.45	MALREKA00AA168L00K
	10	5 x 11	0.08	10.6	76	0.45	MALREKA00AA210L00K
	15	6.3 x 11	0.08	7.08	89	0.48	MALREKA00BA215L00K
	22	6.3 x 11	0.08	4.83	124	0.48	MALREKA00BA222L00K
	33	8 x 11.5	0.08	3.22	178	1.20	MALREKA00PB233L00K
	47	8 x 11.5	0.08	2.26	222	1.20	MALREKA00PB247L00K
	68	10 x 12.5	0.08	1.56	293	1.85	MALREKA00DC268L00K
	100	10 x 16	0.08	1.06	388	2.30	MALREKA00DD310L00K
	150	10 x 20	0.08	0.71	528	2.80	MALREKA00DE315L00K
	220	12.5 x 20	0.08	0.48	737	4.10	MALREKA00FE322L00K
	330	12.5 x 25	0.08	0.32	1002	5.60	MALREKA00FG333L00K
	470	16 x 25	0.08	0.23	1328	7.50	MALREKA00JG347L00K
	680	16 x 31.5	0.08	0.16	1643	9.50	MALREKA00JS368L00K
	1000	18 x 31.5	0.08	0.11	1965	12.0	MALREKA00KS410L00K
160	3.3	6.3 x 11	0.15	60.3	45	0.48	MALREKA00BA133M00K
	4.7	6.3 x 11	0.15	42.3	53	0.48	MALREKA00BA147M00K
	6.8	8 x 11.5	0.15	29.3	76	1.20	MALREKA00PB168M00K
	15	10 x 12.5	0.15	13.3	131	1.85	MALREKA00DC215M00K
	22	10 x 12.5	0.15	9.05	156	1.85	MALREKA00DC222M00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/85 °C (mA)	WEIGHT (g)	CATALOG NUMBER (LONG LEADS)
160	33	10 x 16	0.15	6.03	209	2.30	MALREKA00DD233M00K
	68	12.5 x 20	0.15	2.93	391	4.10	MALREKA00FE268M00K
	100	12.5 x 25	0.15	1.99	516	5.60	MALREKA00FG310M00K
	150	16 x 20	0.15	1.33	632	5.70	MALREKA00JE315M00K
	220	16 x 25	0.15	0.90	873	7.50	MALREKA00JG322M00K
	330	16 x 35.5	0.15	0.60	1152	10.5	MALREKA00JL333M00K
	470	18 x 40	0.15	0.42	1434	16.0	MALREKA00KK347M00K
200	10	8 x 11.5	0.15	19.9	96	1.20	MALREKA00PB210S00K
	47	10 x 20	0.15	4.23	293	2.80	MALREKA00DE247S00K
	68	12.5 x 25	0.15	2.93	426	5.60	MALREKA00FG268S00K
	150	16 x 25	0.15	1.33	691	7.50	MALREKA00JG315S00K
	220	18 x 31.5	0.15	0.90	962	12.0	MALREKA00KS322S00K
	330	18 x 35.5	0.15	0.60	1206	13.0	MALREKA00KL333S00K
250	3.3	6.3 x 11	0.15	60.3	48	0.48	MALREKA00BA133N00K
	4.7	6.3 x 11	0.15	42.3	57	0.48	MALREKA00BA147N00K
	6.8	8 x 11.5	0.15	29.3	76	1.20	MALREKA00PB168N00K
	15	10 x 16	0.15	13.3	143	2.30	MALREKA00DD215N00K
	22	10 x 16	0.15	9.05	170	2.30	MALREKA00DD222N00K
	33	10 x 20	0.15	6.03	247	2.80	MALREKA00DE233N00K
	47	12.5 x 20	0.15	4.23	319	4.10	MALREKA00FE247N00K
	68	16 x 20	0.15	2.93	425	5.70	MALREKA00JE268N00K
	100	16 x 25	0.15	1.99	564	7.50	MALREKA00JG310N00K
	150	16 x 31.5	0.15	1.33	726	9.50	MALREKA00JS315N00K
	220	18 x 35.5	0.15	0.90	988	13.0	MALREKA00KL322N00K
350	4.7	8 x 11.5	0.20	56.5	66	1.20	MALREKA00PB147O00K
	10	10 x 12.5	0.20	26.5	107	1.85	MALREKA00DC210O00K
	15	10 x 20	0.20	17.7	156	2.80	MALREKA00DE215O00K
	47	16 x 20	0.20	5.65	353	5.70	MALREKA00JE247O00K
	68	16 x 25	0.20	3.90	465	7.50	MALREKA00JG268O00K
	100	18 x 31.5	0.20	2.65	592	12.0	MALREKA00KS310O00K
400	6.8	10 x 12.5	0.20	39.0	87	1.85	MALREKA00DC168X00K
	10	10 x 16	0.20	26.5	115	2.30	MALREKA00DD210X00K
	22	12.5 x 20	0.20	12.1	218	4.10	MALREKA00FE222X00K
	33	12.5 x 25	0.20	8.04	296	5.60	MALREKA00FG233X00K
	47	16 x 25	0.20	5.65	387	7.50	MALREKA00JG247X00K
	68	16 x 31.5	0.20	3.90	488	9.50	MALREKA00JS268X00K
	100	18 x 35.5	0.20	2.65	667	13.0	MALREKA00KL310X00K
	150	18 x 40	0.20	1.77	863	16.0	MALREKA00KK315X00K
450	1.0	8 x 11.5	0.20	265	26	1.20	MALREKA00PB110P00K
	1.5	8 x 11.5	0.20	177	32	1.20	MALREKA00PB115P00K
	2.2	8 x 11.5	0.20	121	33	1.20	MALREKA00PB122P00K
	3.3	8 x 11.5	0.20	80.4	50	1.20	MALREKA00PB133P00K
	4.7	10 x 12.5	0.20	56.5	72	1.85	MALREKA00DC147P00K
	6.8	10 x 16	0.20	39.0	86	2.30	MALREKA00DD168P00K
	10	10 x 20	0.20	26.5	115	2.80	MALREKA00DE210P00K
	15	12.5 x 20	0.20	17.7	164	4.10	MALREKA00FE215P00K
	22	12.5 x 25	0.20	12.1	217	5.60	MALREKA00FG222P00K
	33	16 x 25	0.20	8.04	294	7.50	MALREKA00JG233P00K
	47	16 x 31.5	0.20	5.65	384	9.50	MALREKA00JS247P00K
	68	16 x 35.5	0.20	3.90	503	10.5	MALREKA00JL268P00K
	100	18 x 40	0.20	2.65	546	16.0	MALREKA00KK310P00K

LOW TEMPERATURE BEHAVIOR (at 120 Hz)

IMPEDANCE RATIO Z(T2)/Z(T1)	RATED VOLTAGE (V)								
T2/T1	6.3	10	16	25	35	50 ~ 100	160	200 ~ 350	400 ~ 450
- 25/+ 20 °C	5	4	3	2	2	2	4	6	12
- 40/+ 20 °C	12	10	8	5	4	3	6	8	-

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 1 minute at U_R	$I_{L1} \leq 0.03 \times C_R \times U_R$ or 4 µA
	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA
	After 5 minutes at U_R	$I_{L5} \leq 0.02 \times C_R \times U_R$ or 15 µA
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R	ESR = tan $\delta/2\,\pi\,f\,C_R$

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY

FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R \leq 100$ V		
	$C_R \leq 47$ µF	C_R = 68 to 680 µF	$C_R \geq 1000$ µF
50	0.75	0.80	0.85
120	1.00	1.00	1.00
300	1.35	1.25	1.10
1000	1.55	1.35	1.15
≥ 10 000	2.00	1.50	1.15

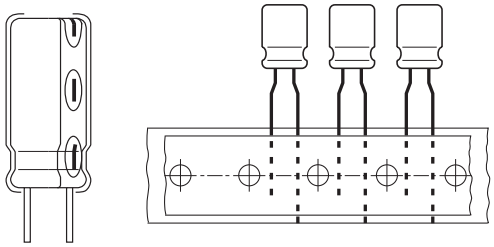
MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY

FREQUENCY (Hz)	I_R MULTIPLIER FOR U_R 160 V to ≤ 450 V	
	C_R = 47 to 220 µF	$C_R \geq 330$ µF
50	0.80	0.90
120	1.00	1.00
300	1.25	1.10
1000	1.40	1.13
≥ 10 000	1.60	1.15

TEST PROCEDURES AND REQUIREMENTS

TEST	PROCEDURE (QUICK REFERENCE)	REQUIREMENTS
Load life	T_{amb} = 85 °C U_R and I_R applied After 2000 hours	Δ C/C: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit
Shelf life	T_{amb} = 85 °C No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 20 % of initial value $I_L \leq$ spec.limit tan $\delta \leq 2$ x spec. limit

Aluminum Capacitors
Radial Style



Component outlines

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case
- Miniaturized, high CV-product per unit volume
- Extended temperature range: 105 °C
- RoHS compliant

RoHS COMPLIANT

APPLICATIONS

- General purpose, industrial and audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Portable and mobile equipment (small size, low mass)

QUICK REFERENCE DATA

DESCRIPTION	UNIT	VALUE		
Nominal case size (Ø D x L)	mm	5 x 11 to 8 x 11.5	10 x 12.5 to 18 x 40	
Rated capacitance range C_R	µF	2.2 to 22 000		
Capacitance tolerance	%	± 20		
Rated voltage range	V	6.3 to 100	160 to 350	400 to 450
Category temperature range	°C	- 55 to + 105	- 40 to + 105	- 25 to + 105
Load life	h	1000	2000	
Based on sectional specification		IEC 60384-4/EN 130300		
Climatic category IEC 60068		55/105/56	40/105/56	25/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	RATED VOLTAGE (V) (> 100 V see next page)							
	6.3	10	16	25	35	50	63	100
2.2	→	→	→	→	→	→	5 x 11	5 x 11
3.3	→	→	→	→	→	→	5 x 11	5 x 11
4.7	→	→	→	→	→	→	5 x 11	5 x 11
6.8	→	→	→	→	→	→	5 x 11	5 x 11
10	→	→	→	→	→	→	5 x 11	5 x 11
15	→	→	→	→	→	→	5 x 11	6.3 x 11
22	→	→	→	→	→	→	5 x 11	6.3 x 11
33	→	→	→	→	→	5 x 11	6.3 x 11	8 x 11.5
47	→	→	→	→	5 x 11	→	6.3 x 11	10 x 12.5
68	→	→	→	5 x 11	6.3 x 11	→	8 x 11.5	10 x 16
100	→	→	5 x 11	→	6.3 x 11	→	8 x 11.5	10 x 20
150	→	5 x 11	→	6.3 x 11	8 x 11.5	→	10 x 12.5	12.5 x 20
220	→	5 x 11	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16	12.5 x 25
330	→	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16	10 x 20	16 x 25
470	→	6.3 x 11	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	16 x 25
680	8 x 11.5	→	10 x 12.5	10 x 16	12.5 x 16	12.5 x 20	12.5 x 25	16 x 31.5
1000	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	18 x 40
1500	→	10 x 16	12.5 x 16	12.5 x 20	16 x 20	16 x 25	16 x 35.5	-
2200	→	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5	16 x 35.5	-
3300	12.5 x 16	12.5 x 20	12.5 x 25	16 x 25	16 x 35.5	16 x 35.5	18 x 40	-
4700	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5	16 x 35.5	-	-	-
6800	12.5 x 25	16 x 25	16 x 31.5	18 x 35.5	-	-	-	-
10 000	16 x 25	16 x 35.5	18 x 35.5	-	-	-	-	-
15 000	16 x 35.5	18 x 35.5	-	-	-	-	-	-
22 000	18 x 40	-	-	-	-	-	-	-

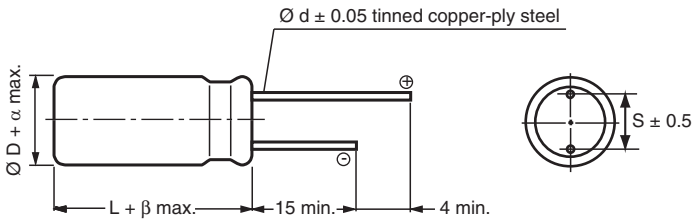
Note
10 % capacitance tolerance on request

For technical questions, contact: aluminumcaps1@vishay.com

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)						
C_R (µF)	RATED VOLTAGE (V)					
	160	200	250	350	400	450
2.2	→	→	6.3 x 11	→	8 x 11.5	10 x 12.5
3.3	→	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16
4.7	6.3 x 11	→	8 x 11.5	→	10 x 12.5	10 x 16
6.8	8 x 11.5	→	10 x 12.5	→	10 x 16	10 x 20
10	→	→	10 x 12.5	10 x 16	10 x 20	12.5 x 20
15	→	→	10 x 16	10 x 20	12.5 x 20	12.5 x 25
22	→	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25
33	→	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5
47	→	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5	16 x 35.5
68	12.5 x 25	16 x 20	16 x 25	16 x 31.5	18 x 35.5	18 x 40
100	12.5 x 25	16 x 25	16 x 31.5	18 x 35.5	18 x 40	-
150	16 x 25	16 x 35.5	18 x 35.5	18 x 40	-	-
220	16 x 31.5	18 x 35.5	18 x 40	-	-	-
330	18 x 35.5	18 x 40	-	-	-	-
470	18 x 40	-	-	-	-	-

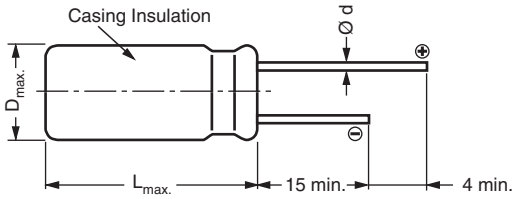
Note
10 % capacitance tolerance on request

RADIAL STYLE: DIMENSIONS in millimeters

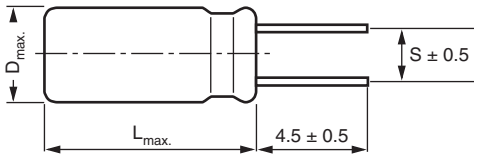


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

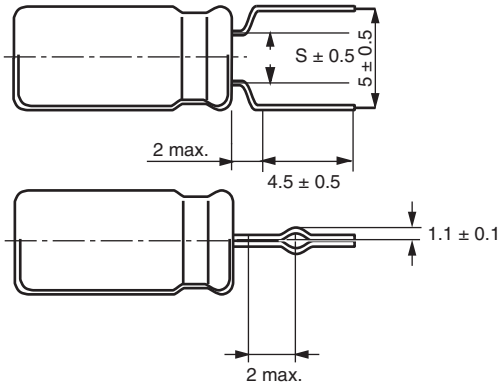
DIMENSIONS in millimeters AND AVAILABLE FORMS



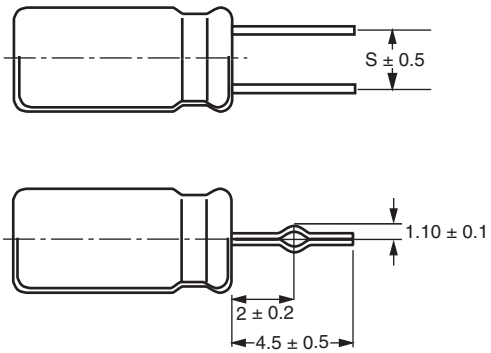
Ø D ≤ 18 long leads MALREKB00...



Ø D ≤ 18 shortened leads MALREKB05...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKB09...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKB06...
(S = 5/7.5 mm)

GENERAL NOTE

- For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service
- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	calculated equivalent series resistance at 120 Hz
I_R	rated ripple current (rms) at 120 Hz and upper category temperature

Note
Unless otherwise specified, all electrical values apply at T_a = 20 °C , P = 80 to 120 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

EKB 3300 µF/25 V, ± 20 %, size: 16 x 25 mm
Leads: Long
Ordering code: MALREKB00JG433E00K

Leads: Short
Ordering code: MALREKB05...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKB09...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKB06 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
6.3	680	8 x 11.5	0.28	0.55	348	1.10	MALREKB00PB368B00K
	1000	8 x 11.5	0.28	0.37	422	1.10	MALREKB00PB410B00K
	3300	12.5 x 16	0.34	0.14	983	3.00	MALREKB00FD433B00K
	4700	12.5 x 20	0.36	0.10	1219	4.00	MALREKB00FE447B00K
	6800	12.5 x 25	0.40	0.08	1480	5.00	MALREKB00FG468B00K
	10 000	16 x 25	0.46	0.06	1807	8.50	MALREKB00JG510B00K
	15 000	16 x 35.5	0.56	0.05	2233	11.0	MALREKB00JL515B00K
	22 000	18 x 40	0.70	0.04	2652	14.6	MALREKB00KK522B00K
10	150	5 x 11	0.24	2.12	134	0.45	MALREKB00AA315C00K
	220	5 x 11	0.24	1.45	162	0.45	MALREKB00AA322C00K
	330	6.3 x 11	0.24	0.96	228	0.46	MALREKB00BA333C00K
	470	6.3 x 11	0.24	0.68	272	0.46	MALREKB00BA347C00K
	1000	10 x 12.5	0.24	0.32	544	2.05	MALREKB00DC410C00K
	1500	10 x 16	0.26	0.23	680	2.20	MALREKB00DD415C00K
	2200	10 x 20	0.28	0.17	844	3.10	MALREKB00DE422C00K
	3300	12.5 x 20	0.30	0.12	1148	4.00	MALREKB00FE433C00K
	4700	12.5 x 25	0.32	0.09	1421	5.00	MALREKB00FG447C00K
	6800	16 x 25	0.36	0.07	1737	8.50	MALREKB00JG468C00K
	10 000	16 x 35.5	0.42	0.06	2172	11.0	MALREKB00JL510C00K
	15 000	18 x 35.5	0.52	0.05	2482	14.0	MALREKB00KL515C00K
16	100	5 x 11	0.20	2.65	119	0.45	MALREKB00AA310D00K
	220	6.3 x 11	0.20	1.21	203	0.46	MALREKB00BA322D00K
	470	8 x 11.5	0.20	0.56	349	1.10	MALREKB00PB347D00K
	680	10 x 12.5	0.20	0.39	488	2.05	MALREKB00DC368D00K
	1000	10 x 16	0.20	0.27	648	2.20	MALREKB00DD410D00K
	1500	12.5 x 16	0.22	0.19	862	3.00	MALREKB00FD415D00K
	2200	12.5 x 20	0.24	0.14	1055	4.00	MALREKB00FE422D00K
	3300	12.5 x 25	0.26	0.10	1323	5.00	MALREKB00FG433D00K
	4700	16 x 25	0.28	0.08	1657	8.50	MALREKB00JG447D00K
	6800	16 x 31.5	0.32	0.06	1982	10.0	MALREKB00JS468D00K
	10 000	18 x 35.5	0.38	0.05	2409	14.0	MALREKB00KL510D00K
25	68	5 x 11	0.16	3.12	108	0.45	MALREKB00AA268E00K
	150	6.3 x 11	0.16	1.41	185	0.46	MALREKB00BA315E00K
	330	8 x 11.5	0.16	0.64	324	1.10	MALREKB00PB333E00K
	470	10 x 12.5	0.16	0.45	449	2.05	MALREKB00DC347E00K
	680	10 x 16	0.16	0.31	591	2.20	MALREKB00DD368E00K
	1000	10 x 20	0.16	0.21	782	3.10	MALREKB00DE410E00K
	1500	12.5 x 20	0.18	0.16	1017	4.00	MALREKB00FE415E00K
	2200	12.5 x 25	0.20	0.12	1235	5.00	MALREKB00FG422E00K
	3300	16 x 25	0.22	0.09	1562	8.50	MALREKB00JG433E00K
	4700	16 x 31.5	0.24	0.07	1916	10.0	MALREKB00JS447E00K
	6800	18 x 35.5	0.28	0.05	2335	14.0	MALREKB00KL468E00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
35	47	5 x 11	0.14	3.95	96	0.45	MALREKB00AA247F00K
	68	6.3 x 11	0.14	2.73	132	0.46	MALREKB00BA268F00K
	100	6.3 x 11	0.14	1.86	160	0.46	MALREKB00BA310F00K
	150	8 x 11.5	0.14	1.24	231	1.10	MALREKB00PB315F00K
	220	8 x 11.5	0.14	0.84	280	1.10	MALREKB00PB322F00K
	330	10 x 12.5	0.14	0.56	399	2.05	MALREKB00DC333F00K
	470	10 x 16	0.14	0.40	521	2.20	MALREKB00DD347F00K
	680	12.5 x 16	0.14	0.27	740	3.00	MALREKB00FD368F00K
	1000	12.5 x 20	0.14	0.19	974	4.00	MALREKB00FE410F00K
	1500	16 x 20	0.16	0.14	1188	6.00	MALREKB00JE415F00K
	2200	16 x 25	0.18	0.11	1426	8.50	MALREKB00JG422F00K
	3300	16 x 35.5	0.20	0.08	1857	11.0	MALREKB00JL433F00K
	4700	16 x 35.5	0.22	0.06	2224	14.0	MALREKB00JL447F00K
50	33	5 x 11	0.12	4.82	92	0.45	MALREKB00AA233H00K
	220	10 x 12.5	0.12	0.72	376	2.05	MALREKB00DC322H00K
	330	10 x 16	0.12	0.48	504	2.20	MALREKB00DD333H00K
	470	10 x 20	0.12	0.34	657	3.10	MALREKB00DE347H00K
	680	12.5 x 20	0.12	0.23	927	4.00	MALREKB00FE368H00K
	1000	12.5 x 25	0.12	0.16	1226	5.00	MALREKB00FG410H00K
	1500	16 x 25	0.14	0.12	1442	8.50	MALREKB00JG415H00K
	2200	16 x 31.5	0.16	0.10	1442	10.0	MALREKB00JS422H00K
	3300	16 x 35.5	0.18	0.07	1794	11.0	MALREKB00JL433H00K
63	2.2	5 x 11	0.10	60.29	26	0.45	MALREKB00AA122J00K
	3.3	5 x 11	0.10	40.19	32	0.45	MALREKB00AA133J00K
	4.7	5 x 11	0.10	28.22	38	0.45	MALREKB00AA147J00K
	6.8	5 x 11	0.10	19.50	46	0.45	MALREKB00AA168J00K
	10	5 x 11	0.10	13.26	56	0.45	MALREKB00AA210J00K
	15	5 x 11	0.10	8.84	68	0.45	MALREKB00AA215J00K
	22	5 x 11	0.10	6.03	83	0.45	MALREKB00AA222J00K
	33	6.3 x 11	0.10	4.02	116	0.46	MALREKB00BA233J00K
	47	6.3 x 11	0.10	2.82	139	0.46	MALREKB00BA247J00K
	68	8 x 11.5	0.10	1.95	197	1.10	MALREKB00PB268J00K
	100	8 x 11.5	0.10	1.33	239	1.10	MALREKB00PB310J00K
	150	10 x 12.5	0.10	0.88	340	2.05	MALREKB00DC315J00K
	220	10 x 16	0.10	0.60	451	2.20	MALREKB00DD322J00K
	330	10 x 20	0.10	0.40	603	3.10	MALREKB00DE333J00K
	470	12.5 x 20	0.10	0.28	844	4.00	MALREKB00FE347J00K
	680	12.5 x 25	0.10	0.20	1107	5.00	MALREKB00FG368J00K
	1000	16 x 25	0.10	0.13	1490	8.50	MALREKB00JG410J00K
	1500	16 x 35.5	0.12	0.11	1770	11.0	MALREKB00JL415J00K
	2200	16 x 35.5	0.14	0.08	1770	11.0	MALREKB00JL422J00K
	3300	18 x 40	0.16	0.06	2689	14.6	MALREKB00KK433J00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
100	2.2	5 x 11	0.08	48.23	26	0.45	MALREKB00AA122L00K
	3.3	5 x 11	0.08	32.15	32	0.45	MALREKB00AA133L00K
	4.7	5 x 11	0.08	22.58	38	0.45	MALREKB00AA147L00K
	6.8	5 x 11	0.08	15.60	46	0.45	MALREKB00AA168L00K
	10	5 x 11	0.08	10.61	56	0.45	MALREKB00AA210L00K
	15	6.3 x 11	0.08	7.07	78	0.46	MALREKB00BA215L00K
	22	6.3 x 11	0.08	4.82	95	0.46	MALREKB00BA222L00K
	33	8 x 11.5	0.08	3.22	137	1.10	MALREKB00PB233L00K
	47	10 x 12.5	0.08	2.26	190	2.05	MALREKB00DC247L00K
	68	10 x 16	0.08	1.56	251	2.20	MALREKB00DD268L00K
	100	10 x 20	0.08	1.06	332	3.10	MALREKB00DE310L00K
	150	12.5 x 20	0.08	0.71	477	4.00	MALREKB00FE315L00K
	220	12.5 x 25	0.08	0.48	630	5.00	MALREKB00FG322L00K
	330	16 x 25	0.08	0.32	856	8.50	MALREKB00JG333L00K
	470	16 x 25	0.08	0.23	1021	8.50	MALREKB00JG347L00K
	680	16 x 31.5	0.08	0.16	1344	10.0	MALREKB00JS368L00K
	1000	18 x 40	0.08	0.11	1925	14.6	MALREKB00KK410L00K
160	4.7	6.3 x 11	0.15	42.33	34	0.46	MALREKB00BA147M00K
	6.8	8 x 11.5	0.15	29.26	49	1.10	MALREKB00PB168M00K
	68	12.5 x 25	0.15	2.93	273	5.00	MALREKB00FG268M00K
	100	12.5 x 25	0.15	1.99	331	5.00	MALREKB00FG310M00K
	150	16 x 25	0.15	1.33	450	8.50	MALREKB00JG315M00K
	220	16 x 31.5	0.15	0.90	596	10.0	MALREKB00JS322M00K
	330	18 x 35.5	0.15	0.60	822	14.0	MALREKB00KL333M00K
	470	18 x 40	0.15	0.42	1015	14.6	MALREKB00KK347M00K
200	3.3	6.3 x 11	0.15	60.29	29	0.46	MALREKB00BA133S00K
	22	10 x 16	0.15	9.04	111	2.20	MALREKB00DD222S00K
	33	10 x 20	0.15	6.03	149	3.10	MALREKB00DE233S00K
	47	12.5 x 20	0.15	4.23	208	4.00	MALREKB00FE247S00K
	68	16 x 20	0.15	2.93	279	6.00	MALREKB00JE268S00K
	100	16 x 25	0.15	1.99	368	8.50	MALREKB00JG310S00K
	150	16 x 35.5	0.15	1.33	517	11.0	MALREKB00JL315S00K
	220	18 x 35.5	0.15	0.90	671	14.0	MALREKB00KL322S00K
	330	18 x 40	0.15	0.60	850	14.6	MALREKB00KK333S00K
250	2.2	6.3 x 11	0.15	90.43	23	0.46	MALREKB00BA122N00K
	4.7	8 x 11.5	0.15	42.33	40	1.10	MALREKB00PB147N00K
	6.8	10 x 12.5	0.15	29.26	56	2.05	MALREKB00DC168N00K
	10	10 x 12.5	0.15	19.89	68	2.05	MALREKB00DC210N00K
	15	10 x 16	0.15	13.26	92	2.20	MALREKB00DD215N00K
	22	10 x 20	0.15	9.04	121	3.10	MALREKB00DE222N00K
	33	12.5 x 20	0.15	6.03	175	4.00	MALREKB00FE233N00K
	47	12.5 x 25	0.15	4.23	227	5.00	MALREKB00FG247N00K
	68	16 x 25	0.15	2.93	303	8.50	MALREKB00JG268N00K
	100	16 x 31.5	0.15	1.99	402	10.0	MALREKB00JS310N00K
	150	18 x 35.5	0.15	1.33	554	14.0	MALREKB00KL315N00K
	220	18 x 40	0.15	0.90	694	14.6	MALREKB00KK322N00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
350	3.3	8 x 11.5	0.20	80.38	34	1.10	MALREKB00PB133O00K
	10	10 x 16	0.20	26.53	75	2.20	MALREKB00DD210O00K
	15	10 x 20	0.20	17.68	100	3.10	MALREKB00DE215O00K
	22	12.5 x 20	0.20	12.06	143	4.00	MALREKB00FE222O00K
	33	12.5 x 25	0.20	8.04	190	5.00	MALREKB00FG233O00K
	47	16 x 25	0.20	5.64	252	8.50	MALREKB00JG247O00K
	68	16 x 31.5	0.20	3.90	332	10.0	MALREKB00JS268O00K
	100	18 x 35.5	0.20	2.65	407	14.0	MALREKB00KL310O00K
	150	18 x 40	0.20	1.77	523	14.6	MALREKB00KK315O00K
400	2.2	8 x 11.5	0.20	120.6	28	1.10	MALREKB00PB122X00K
	3.3	10 x 12.5	0.20	80.38	39	2.05	MALREKB00DC133X00K
	4.7	10 x 12.5	0.20	56.44	47	2.05	MALREKB00DC147X00K
	6.8	10 x 16	0.20	39.01	62	2.20	MALREKB00DD168X00K
	10	10 x 20	0.20	26.53	82	3.10	MALREKB00DE210X00K
	15	12.5 x 20	0.20	17.68	118	4.00	MALREKB00FE215X00K
	22	12.5 x 25	0.20	12.06	155	5.00	MALREKB00FG222X00K
	33	16 x 25	0.20	8.04	211	8.50	MALREKB00JG233X00K
	47	16 x 31.5	0.20	5.64	276	10.0	MALREKB00JS247X00K
	68	18 x 35.5	0.20	3.90	373	14.0	MALREKB00KL268X00K
	100	18 x 40	0.20	2.65	427	14.6	MALREKB00KK310X00K
450	2.2	10 x 12.5	0.20	120.6	27	2.05	MALREKB00DC122P00K
	3.3	10 x 16	0.20	80.38	36	2.20	MALREKB00DD133P00K
	4.7	10 x 16	0.20	56.44	43	2.20	MALREKB00DD147P00K
	6.8	10 x 20	0.20	39.01	56	3.10	MALREKB00DE168P00K
	10	12.5 x 20	0.20	26.53	80	4.00	MALREKB00FE210P00K
	15	12.5 x 25	0.20	17.68	107	5.00	MALREKB00FG215P00K
	22	16 x 25	0.20	12.06	144	8.50	MALREKB00JG222P00K
	33	16 x 31.5	0.20	8.04	193	10.0	MALREKB00JS233P00K
	47	16 x 35.5	0.20	5.64	242	11.0	MALREKB00JL247P00K
	68	18 x 40	0.20	3.90	352	14.6	MALREKB00KK268P00K

LOW TEMPERATURE BEHAVIOR

IMPEDANCE RATIO Z(T2)/Z(T1)	RATED VOLTAGE (V)									
T2/T1	**6.3**	**10**	**16**	**25**	**35**	**50 ~ 100**	**160**	**200 ~ 350**	**400**	**450**
- 25/+ 20 °C	5	4	3	2	2	2	3	4	6	10
- 40/+ 20 °C	10	8	6	4	3	3	4	8	-	-

ADDITIONAL ELECTRICAL DATA

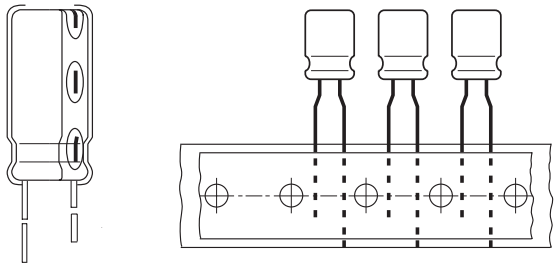
PARAMETER	CONDITIONS	VALUE
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 1 minute at U_R	$I_{L1} \leq 0.03 \times C_R \times U_R$ or 4 µA for $U_R \leq 100$ V (whichever is greater)
	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA for $U_R \leq 100$ V (whichever is greater)
	After 5 minutes at U_R	$I_{L5} \leq 0.02 \times C_R \times U_R$ + 15 µA for $U_R > 100$ V (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R	ESR = tan $\delta / 2 \pi f C_R$

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R \leq 100$ V		
	$C_R \leq 47$ µF	$C_R = 68$ to 680 µF	$C_R \geq 1000$ µF
50	0.75	0.80	0.85
120	1.00	1.00	1.00
300	1.35	1.25	1.10
1000	1.55	1.35	1.15
≥ 10 000	2.00	1.50	1.15

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	I_R MULTIPLIER FOR U_R 160 V to ≤ 450 V	
	$C_R = 47$ to 220 µF	$C_R \geq 330$ µF
50	0.80	0.90
120	1.00	1.00
300	1.25	1.10
1000	1.40	1.13
≥ 10 000	1.60	1.15

TEST PROCEDURES AND REQUIREMENTS		
TEST	PROCEDURE (QUICK REFERENCE)	REQUIREMENTS
Load life	T_{amb} = 105 °C U_R and I_R applied After 1000 hours Ø 5, Ø 6.3, Ø 8 mm After 2000 hours ≥ Ø 10 mm	Δ C/C: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit
Shelf life	T_{amb} = 105 °C No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 20 % of initial value $I_L \leq$ spec.limit tan $\delta \leq 2$ x spec. limit

Aluminum Capacitors
Low Leakage Current Radial Style



Component outlines

FEATURES

- Polarized aluminum electrolytic capacitor
- High CU product with miniature dimensions
- Low leakage current
- Low energy requirement
- Temperature range 105 °C
- RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

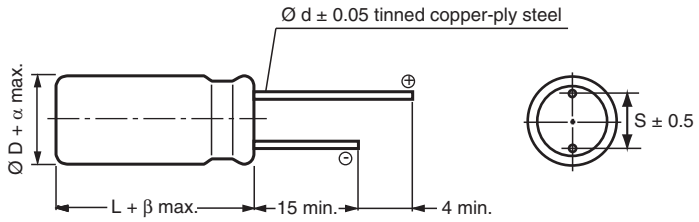
- Industrial electronics, automotive electronics, audio/video systems
- Coupling, decoupling, timing elements, storage
- Portable and mobile units

QUICK REFERENCE DATA		
DESCRIPTION	**UNIT**	**VALUE**
Nominal case size (Ø D x L)	mm	5 x 11 to 10 x 12.5
Rated capacitance range C_R	µF	0.10 to 330
Capacitance tolerance	%	± 20
Rated voltage range	V	10 to 50
Category temperature range	°C	- 55 to + 105
Load life	h	1000
Based on sectional specification		IEC 60384-4/EN 130300
Climatic category IEC 60068		55/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZE (Ø D x L in mm)

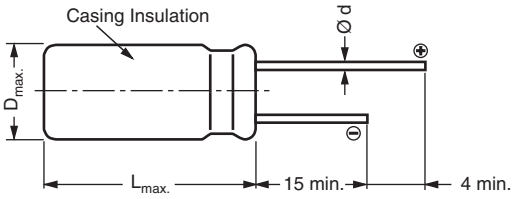
C_R (µF)	RATED VOLTAGE (V)				
	10	**16**	**25**	**35**	**50**
0.10	→	→	→	→	5 x 11
0.15	→	→	→	→	5 x 11
0.22	→	→	→	→	5 x 11
0.33	→	→	→	→	5 x 11
0.47	→	→	→	→	5 x 11
0.68	→	→	→	→	5 x 11
1.0	→	→	→	→	5 x 11
1.5	→	→	→	→	5 x 11
2.2	→	→	→	→	5 x 11
3.3	→	→	→	→	5 x 11
4.7	→	→	→	→	5 x 11
6.8	→	→	→	→	5 x 11
10	→	→	→	→	5 x 11
15	→	→	→	5 x 11	6.3 x 11
22	→	→	5 x 11	→	6.3 x 11
33	→	5 x 11	→	6.3 x 11	8 x 11.5
47	5 x 11	→	6.3 x 11	→	8 x 11.5
68	→	6.3 x 11	→	8 x 11.5	10 x 12.5
100	6.3 x 11	→	8 x 11.5	10 x 12.5	-
150	→	8 x 11.5	10 x 12.5	-	-
220	8 x 11.5	10 x 12.5	-	-	-
330	10 x 12.5	-	-	-	-

RADIAL STYLE: DIMENSIONS in millimeters

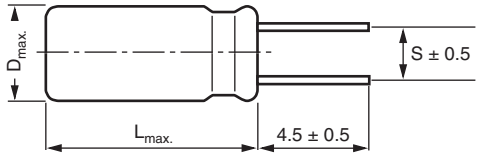


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

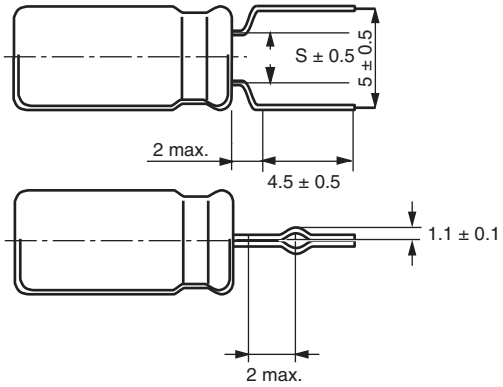
DIMENSIONS in millimeters AND AVAILABLE FORMS



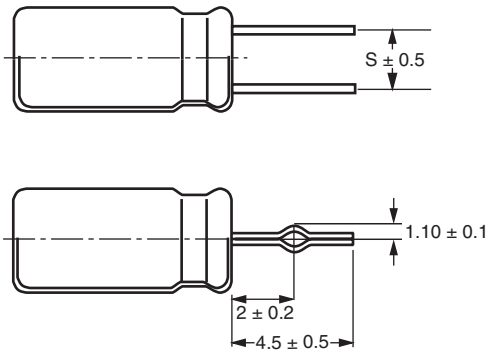
Ø D ≤ 18 long leads MALREKI00...



Ø D ≤ 18 shortened leads MALREKI05...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKI09...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKI06...
(S = 5/7.5 mm)

GENERAL NOTE

- For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service
- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	max. equivalent series resistance at 120 Hz
I_{L2}	max. leakage current for acceptance test after 2 minutes at U_R
I_R	rated alternating current (rms) at 120 Hz and upper category temperature

Note
Unless otherwise specified, all electrical values apply at T_a = 20 °C, P = 80 to 120 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

EKI 220 µF/16 V, ± 20 %, size: 10 x 12.5 mm
Leads: Long
Ordering code: MALREKI00DC322D00K

Leads: Short
Ordering code: MALREKI05...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKI09...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKI06 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_{L2} (µA)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	ORDERING NUMBER (Long Leads)
10	47	5 x 11	0.15	4.23	0.94	70	0.4	MALREKI00AA247C00K
	100	6.3 x 11	0.15	1.99	2.00	117	0.7	MALREKI00BA310C00K
	220	8 x 11.5	0.15	0.90	4.40	205	1.0	MALREKI00PB322C00K
	330	10 x 12.5	0.15	0.60	6.60	291	1.8	MALREKI00DC333C00K
16	33	5 x 11	0.12	4.82	1.06	65	0.4	MALREKI00AA233D00K
	68	6.3 x 11	0.12	2.34	2.18	108	0.7	MALREKI00BA268D00K
	150	8 x 11.5	0.12	1.06	4.80	189	1.0	MALREKI00PB315D00K
	220	10 x 12.5	0.12	0.72	7.04	266	1.8	MALREKI00DC322D00K
25	22	5 x 11	0.08	4.82	1.10	65	0.4	MALREKI00AA222E00K
	47	6.3 x 11	0.08	2.26	2.35	110	0.7	MALREKI00BA247E00K
	100	8 x 11.5	0.08	1.06	5.00	189	1.0	MALREKI00PB310E00K
	150	10 x 12.5	0.08	0.71	7.50	269	1.8	MALREKI00DC315E00K
35	15	5 x 11	0.08	7.07	1.05	54	0.4	MALREKI00AA215F00K
	33	6.3 x 11	0.08	3.22	2.31	92	0.7	MALREKI00BA233F00K
	68	8 x 11.5	0.08	1.56	4.76	156	1.0	MALREKI00PB268F00K
	100	10 x 12.5	0.08	1.06	7.00	219	1.8	MALREKI00DC310F00K
50	0.10	5 x 11	0.08	1061	0.40	4.4	0.4	MALREKI00AA010H00K
	0.15	5 x 11	0.08	707	0.40	5.4	0.4	MALREKI00AA015H00K
	0.22	5 x 11	0.08	482	0.40	6.5	0.4	MALREKI00AA022H00K
	0.33	5 x 11	0.08	322	0.40	8.0	0.4	MALREKI00AA033H00K
	0.47	5 x 11	0.08	226	0.40	9.6	0.4	MALREKI00AA047H00K
	0.68	5 x 11	0.08	156	0.40	11	0.4	MALREKI00AA068H00K
	1.0	5 x 11	0.08	106	0.40	14	0.4	MALREKI00AA110H00K
	1.5	5 x 11	0.08	70.7	0.40	17	0.4	MALREKI00AA115H00K
	2.2	5 x 11	0.08	48.2	0.40	21	0.4	MALREKI00AA122H00K
	3.3	5 x 11	0.08	32.2	0.40	25	0.4	MALREKI00AA133H00K
	4.7	5 x 11	0.08	22.6	0.47	30	0.4	MALREKI00AA147H00K
	6.8	5 x 11	0.08	15.6	0.68	36	0.4	MALREKI00AA168H00K
	10	5 x 11	0.08	10.6	1.00	44	0.4	MALREKI00AA210H00K
	15	6.3 x 11	0.08	7.07	1.50	62	0.7	MALREKI00BA215H00K
	22	6.3 x 11	0.08	4.82	2.20	75	0.7	MALREKI00BA222H00K
	33	8 x 11.5	0.08	3.22	3.30	109	1.0	MALREKI00PB233H00K
	47	8 x 11.5	0.08	2.26	4.70	129	1.0	MALREKI00PB247H00K
	68	10 x 12.5	0.08	1.56	6.80	181	1.8	MALREKI00DC268H00K

LOW TEMPERATURE BEHAVIOUR (at 120 Hz)					
IMPEDANCE RATIO Z(T2)/Z(T1)	RATED VOLTAGE (V)				
T2/T1	10	16	25	35	50
- 25 °C/+ 20 °C	2	2	1.5	1.5	1.5
- 40 °C/+ 20 °C	4	3	2	2	2

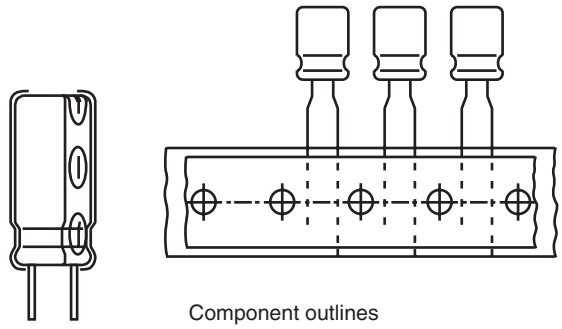
ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 2 minutes at U_R	$I_{L2} \leq 0.002 \times C_R \times U_R$ or 4 µA for $U_R \leq 100$ V (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta/2 \pi f C_R$

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R \leq 100$ V		
	$C_R \leq 47$ µF	$C_R = 68$ to 680 µF	$C_R \geq 1000$ µF
50	0.75	0.80	0.85
120	1.00	1.00	1.00
300	1.35	1.25	1.10
1000	1.55	1.35	1.15
≥ 10 000	2.00	1.50	1.15

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	I_R MULTIPLIER FOR U_R 160 V to ≤ 450 V	
	$C_R = 47$ to 220 µF	$C_R \geq 330$ µF
50	0.80	0.90
120	1.00	1.00
300	1.25	1.10
1000	1.40	1.13
≥ 10 000	1.60	1.15

TEST PROCEDURES AND REQUIREMENTS		
TEST	PROCEDURE (QUICK REFERENCE)	REQUIREMENTS
Load life	T_{amb} = 105 °C U_R and I_R applied After 1000 hours	Δ C/C: ± 15 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 1.5 \times$ spec. limit
Shelf life	No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 15 % of initial value $I_L \leq$ spec.limit tan $\delta \leq 1.5 \times$ spec. limit

Aluminum Capacitors
Radial Style



Component outlines

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case
- Miniaturized, high CV-product per unit volume
- Extended temperature range: 105 °C
- Low impedance
- Long lifetime

Pb-free

RoHS
COMPLIANT

APPLICATIONS

- General purpose, industrial, telecommunications, power supplies and audio-video
- Coupling, decoupling, timing, smoothing, filtering and buffering
- Portable and mobile units (small size, low mass)

QUICK REFERENCE DATA				
DESCRIPTION	**UNIT**	**VALUE**		
Nominal case size (Ø D x L)	mm	5 x 11 to 18 x 40		
Rated capacitance range C_R	µF	0.22 to 15 000		
Capacitance tolerance	%	± 20		
Rated voltage range	V	6.3 to 450		
Category temperature range	°C	6.3 to 350 V		400 to 450 V
Load Life	h	5 x 11 to 6.3 x 11	8 x 11.5	10 x 12.5 to 18 x 40
$U_R \leq 100$ V		2000	3000	5000
$U_R > 100$ V		2000		
Based on sectional specification		IEC 60384-4/EN 130300		
Climatic category IEC 60068		40/105/56		25/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

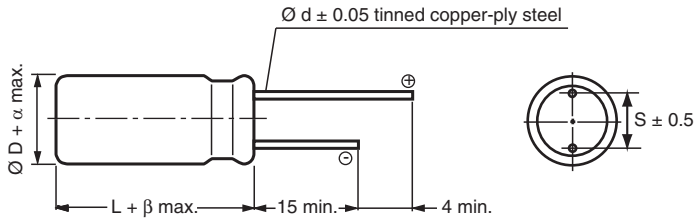
C_R (µF)	RATED VOLTAGE (V) (Continuation see next page)							
	6.3	**10**	**16**	**25**	**35**	**50**	**63**	**100**
0.22	→	→	→	→	→	5 x 11	-	-
0.47	→	→	→	→	→	5 x 11	-	-
1.0	→	→	→	→	→	5 x 11	-	-
2.2	→	→	→	→	→	5 x 11	-	5 x 11
3.3	→	→	→	→	→	5 x 11	5 x 11	5 x 11
4.7	→	→	→	→	5 x 11	5 x 11	5 x 11	5 x 11
10	→	→	→	→	5 x 11	5 x 11	5 x 11	6.3 x 11
22	→	→	→	→	5 x 11	5 x 11	6.3 x 11	8 x 11.5
33	→	→	→	→	5 x 11	→	6.3 x 11	10 x 12.5
47	→	→	→	5 x 11	6.3 x 11	6.3 x 11	8 x 11.5	10 x 16
100	→	5 x 11	→	6.3 x 11	8 x 11.5	8 x 11.5	10 x 16	12.5 x 20
150	→	→	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 20	12.5 x 25
220	→	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16	10 x 25	16 x 25
330	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	16 x 31.5
470	→	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	16 x 20	18 x 40
1000	10 x 12.5	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 35.5	-
1500	→	10 x 20	12.5 x 20	16 x 20	16 x 25	16 x 31.5	-	-
2200	→	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5	18 x 35.5	-	-
3300	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5	18 x 35.5	-	-	-
4700	→	16 x 25	16 x 31.5	18 x 35.5	-	-	-	-
6800	16 x 25	16 x 31.5	18 x 35.5	-	-	-	-	-
10 000	16 x 31.5	18 x 35.5	-	-	-	-	-	-
15 000	18 x 35.5	-	-	-	-	-	-	-

Note
10 % capacitance tolerance on request

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)					
C_R (µF)	RATED VOLTAGE (V)				
	160	200	250	400	450
3.3	→	→	→	→	10 x 20
4.7	→	→	→	→	12.5 x 20
10	→	→	10 x 20	10 x 20	12.5 x 25
22	→	10 x 20	12.5 x 20	12.5 x 25	16 x 25
33	10 x 20	12.5 x 20	12.5 x 25	16 x 20	16 x 31.5
47	→	12.5 x 20	12.5 x 25	16 x 25	18 x 31.5
100	→	16 x 25	16 x 31.5	18 x 40	-
150	16 x 31.5	18 x 25	18 x 31.5	-	-
220	16 x 31.5	18 x 31.5	18 x 40	-	-
330	18 x 31.5	-	-	-	-

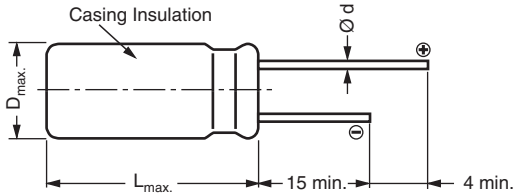
Note
10 % capacitance tolerance on request

RADIAL STYLE: DIMENSIONS in millimeters

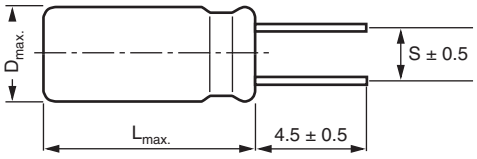


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

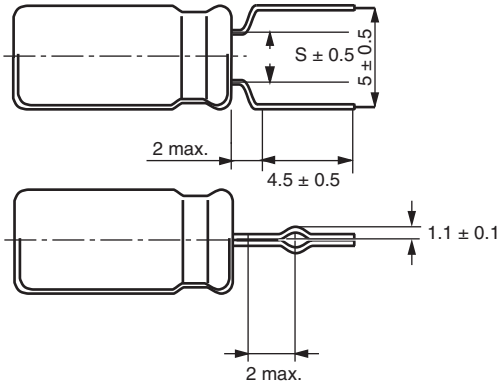
DIMENSIONS in millimeters AND AVAILABLE FORMS



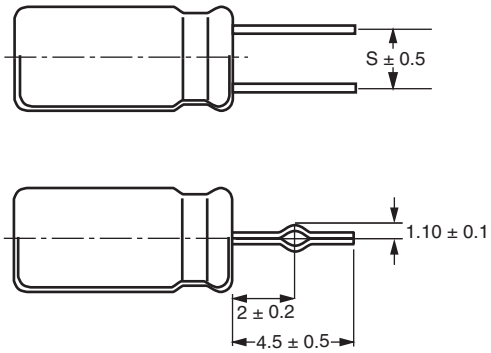
Ø D ≤ 18 long leads MALREKE00...



Ø D ≤ 18 shortened leads MALREKE05...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKE09...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKE06...
(S = 5/7.5 mm)

GENERAL NOTE

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- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	Rated voltage
C_R	Rated capacitance at 120 Hz
tan δ	Max. dissipation factor at 120 Hz
R_{ESR}	Calculated equivalent series resistance at 120 Hz
I_R	Rated ripple current (rms)
Z	Max. impedance

Note

- Unless otherwise specified, all electrical values at T_a = 20 °C, P = 80 kPa to 120 kPa, RH = 45 % to 75 %

ORDERING EXAMPLE

EKE 470 µF/35 V, ± 20 %, size: 10 x 20 mm
Leads: Long
Ordering code: MALREKE00DE34700K

Leads: Short
Ordering code: MALREKE05...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKE09...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKE06 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz/ 20 °C (Ω)	Z 100 kHz/ 20 °C (Ω)	I_R 100 kHz/ 105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (LONG LEADS)
6.3	330	6.3 x 11	0.22	0.884	0.30	280	0.43	MALREKE00BA333B00K
	1000	10 x 12.5	0.22	0.292	0.10	660	1.90	MALREKE00DC410B00K
	3300	12.5 x 20	0.28	0.113	0.050	1400	4.50	MALREKE00FE433B00K
	6800	16 x 25	0.34	0.066	0.030	2100	6.60	MALREKE00JG468B00K
	10 000	16 x 31.5	0.40	0.053	0.025	2600	9.00	MALREKE00JS510B00K
	15 000	18 x 35.5	0.50	0.044	0.022	3000	11.5	MALREKE00KL515B00K
10	100	5 x 11	0.19	2.520	0.65	180	0.42	MALREKE00AA310C00K
	220	6.3 x 11	0.19	1.145	0.30	280	0.43	MALREKE00BA322C00K
	470	8 x 11.5	0.19	0.536	0.14	450	1.05	MALREKE00PB347C00K
	1000	10 x 16	0.19	0.252	0.080	850	2.40	MALREKE00DD410C00K
	1500	10 x 20	0.21	0.186	0.054	1100	3.00	MALREKE00DE415C00K
	2200	12.5 x 20	0.23	0.139	0.050	1400	4.50	MALREKE00FE422C00K
	3300	12.5 x 25	0.25	0.100	0.038	1700	4.70	MALREKE00FG433C00K
	4700	16 x 25	0.27	0.076	0.030	2100	6.60	MALREKE00JG447C00K
	6800	16 x 31.5	0.31	0.060	0.025	2600	9.00	MALREKE00JS468C00K
	10 000	18 x 35.5	0.37	0.049	0.022	3000	11.5	MALREKE00KL510C00K
16	150	6.3 x 11	0.16	1.415	0.30	280	0.43	MALREKE00BA315D00K
	330	8 x 11.5	0.16	0.643	0.14	450	1.05	MALREKE00PB333D00K
	470	10 x 12.5	0.16	0.452	0.10	660	1.90	MALREKE00DC347D00K
	1000	10 x 20	0.16	0.212	0.054	1100	3.00	MALREKE00DE410D00K
	1500	12.5 x 20	0.18	0.159	0.050	1400	4.50	MALREKE00FE415D00K
	2200	12.5 x 25	0.20	0.121	0.038	1700	4.70	MALREKE00FG422D00K
	3300	16 x 25	0.22	0.088	0.030	2100	6.60	MALREKE00JG433D00K
	4700	16 x 31.5	0.24	0.068	0.025	2600	9.00	MALREKE00JS447D00K
	6800	18 x 35.5	0.28	0.055	0.022	3000	11.5	MALREKE00KL468D00K
25	47	5 x 11	0.14	3.951	0.65	180	0.42	MALREKE00AA247E00K
	100	6.3 x 11	0.14	1.857	0.30	280	0.43	MALREKE00BA310E00K
	220	8 x 11.5	0.14	0.844	0.14	450	1.05	MALREKE00PB322E00K
	330	10 x 12.5	0.14	0.563	0.10	660	1.90	MALREKE00DC333E00K
	470	10 x 16	0.14	0.395	0.080	850	2.40	MALREKE00DD347E00K
	1000	12.5 x 20	0.14	0.186	0.050	1400	4.50	MALREKE00FE410E00K
	1500	16 x 20	0.16	0.141	0.030	2100	5.80	MALREKE00JE415E00K
	2200	16 x 25	0.18	0.109	0.030	2100	6.60	MALREKE00JG422E00K
	3300	16 x 31.5	0.20	0.080	0.025	2600	9.00	MALREKE00JS433E00K
	4700	18 x 35.5	0.22	0.062	0.022	3000	11.5	MALREKE00KL447E00K
35	4.7	5 x 11	0.12	33.86	0.70	180	0.42	MALREKE00AA147F00K
	10	5 x 11	0.12	15.92	0.70	180	0.42	MALREKE00AA210F00K
	22	5 x 11	0.12	7.235	0.70	180	0.42	MALREKE00AA222F00K
	33	5 x 11	0.12	4.823	0.65	180	0.42	MALREKE00AA233F00K
	47	6.3 x 11	0.12	3.386	0.30	280	0.43	MALREKE00BA247F00K
	100	8 x 11.5	0.12	1.592	0.14	450	1.05	MALREKE00PB310F00K
	150	8 x 11.5	0.12	1.061	0.14	450	1.05	MALREKE00PB315F00K
	220	10 x 12.5	0.12	0.723	0.10	660	1.90	MALREKE00DC322F00K
	330	10 x 16	0.12	0.482	0.080	850	2.40	MALREKE00DD333F00K
	470	10 x 20	0.12	0.339	0.054	1100	3.00	MALREKE00DE347F00K
	1000	12.5 x 25	0.12	0.159	0.038	1700	4.70	MALREKE00FG410F00K
	1500	16 x 25	0.14	0.124	0.030	2100	6.60	MALREKE00JG415F00K
	2200	16 x 31.5	0.16	0.096	0.025	2600	9.00	MALREKE00JS422F00K
	3300	18 x 35.5	0.18	0.072	0.022	3000	11.5	MALREKE00KL433F00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz/ 20 °C (Ω)	Z 100 kHz/ 20 °C (Ω)	I_R 100 kHz/ 105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (LONG LEADS)
50	0.22	5 x 11	0.10	602.9	8.00	18	0.42	MALREKE00AA022H00K
	0.47	5 x 11	0.10	282.2	5.00	25	0.42	MALREKE00AA047H00K
	1.0	5 x 11	0.10	132.6	3.50	40	0.42	MALREKE00AA110H00K
	2.2	5 x 11	0.10	60.29	3.00	55	0.42	MALREKE00AA122H00K
	3.3	5 x 11	0.10	40.19	2.60	65	0.42	MALREKE00AA133H00K
	4.7	5 x 11	0.10	28.22	2.30	90	0.42	MALREKE00AA147H00K
	10	5 x 11	0.10	13.26	1.40	120	0.42	MALREKE00AA210H00K
	22	5 x 11	0.10	6.029	1.20	150	0.42	MALREKE00AA222H00K
	47	6.3 x 11	0.10	2.822	0.43	250	0.43	MALREKE00BA247H00K
	100	8 x 11.5	0.10	1.326	0.24	340	1.05	MALREKE00PB310H00K
	150	10 x 12.5	0.10	0.884	0.17	490	1.90	MALREKE00DC315H00K
	220	10 x 16	0.10	0.603	0.12	650	2.40	MALREKE00DD322H00K
	330	10 x 20	0.10	0.402	0.10	810	3.00	MALREKE00DE333H00K
	470	12.5 x 20	0.10	0.282	0.085	1100	4.50	MALREKE00FE347H00K
	1000	16 x 25	0.10	0.133	0.043	1600	6.60	MALREKE00JG410H00K
	1500	16 x 31.5	0.12	0.106	0.038	2000	9.00	MALREKE00JS415H00K
	2200	18 x 35.5	0.14	0.084	0.034	2300	11.5	MALREKE00KL422H00K
63	3.3	5 x 11	0.09	36.17	2.00	64	0.42	MALREKE00AA133J00K
	4.7	5 x 11	0.09	25.40	2.00	76	0.42	MALREKE00AA147J00K
	10	5 x 11	0.09	11.94	2.00	111	0.42	MALREKE00AA210J00K
	22	6.3 x 11	0.09	5.426	0.60	190	0.43	MALREKE00BA222J00K
	33	6.3 x 11	0.09	3.617	0.60	233	0.43	MALREKE00BA233J00K
	47	8 x 11.5	0.09	2.540	0.50	328	1.05	MALREKE00PB247J00K
	100	10 x 16	0.09	1.194	0.12	456	2.40	MALREKE00DD310J00K
	150	10 x 20	0.09	0.796	0.10	610	3.00	MALREKE00DE315J00K
	220	10 x 25	0.09	0.543	0.090	809	3.20	MALREKE00DG322J00K
	330	12.5 x 20	0.09	0.362	0.085	1036	4.50	MALREKE00FE333J00K
	470	16 x 20	0.09	0.254	0.050	1411	5.80	MALREKE00JE347J00K
	1000	16 x 35.5	0.09	0.119	0.025	1967	10.0	MALREKE00JL410J00K
100	2.2	5 x 11	0.08	48.23	2.50	52	0.42	MALREKE00AA122L00K
	3.3	5 x 11	0.08	32.15	2.50	64	0.42	MALREKE00AA133L00K
	4.7	5 x 11	0.08	22.58	2.50	76	0.42	MALREKE00AA147L00K
	10	6.3 x 11	0.08	10.61	1.00	128	0.43	MALREKE00BA210L00K
	22	8 x 11.5	0.08	4.823	0.60	224	1.05	MALREKE00PB222L00K
	33	10 x 12.5	0.08	3.215	0.40	319	1.90	MALREKE00DC233L00K
	47	10 x 16	0.08	2.258	0.30	417	2.40	MALREKE00DD247L00K
	100	12.5 x 20	0.08	1.061	0.15	570	4.50	MALREKE00FE310L00K
	150	12.5 x 25	0.08	0.707	0.12	762	4.70	MALREKE00FG315L00K
	220	16 x 25	0.08	0.482	0.070	1250	6.60	MALREKE00JG322L00K
	330	16 x 31.5	0.08	0.322	0.050	1404	9.00	MALREKE00JS333L00K
	470	18 x 40	0.08	0.226	0.030	1980	15.0	MALREKE00KK347L00K
160	33	10 x 20	0.15	6.029	1.30	565	3.00	MALREKE00DE233M00K
	150	16 x 31.5	0.15	1.326	0.22	1300	9.00	MALREKE00JS315M00K
	220	16 x 31.5	0.15	0.904	0.22	1300	9.00	MALREKE00JS322M00K
	330	18 x 31.5	0.15	0.603	0.22	1700	11.0	MALREKE00KS333M00K
200	22	10 x 20	0.15	9.043	1.50	440	3.00	MALREKE00DE222S00K
	33	12.5 x 20	0.15	6.029	0.91	590	4.50	MALREKE00FE233S00K
	47	12.5 x 20	0.15	4.233	0.91	780	4.50	MALREKE00FE247S00K
	100	16 x 25	0.15	1.989	0.27	1280	6.60	MALREKE00JG310S00K
	150	18 x 25	0.15	1.326	0.27	1500	9.00	MALREKE00KG315S00K
	220	18 x 31.5	0.15	0.904	0.22	1700	11.0	MALREKE00KS322S00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz/ 20 °C (Ω)	Z 100 kHz/ 20 °C (Ω)	I_R 100 kHz/ 105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (LONG LEADS)
250	10	10 x 20	0.15	19.89	3.50	300	3.00	MALREKE00DE210N00K
	22	12.5 x 20	0.15	9.043	2.30	480	4.50	MALREKE00FE222N00K
	33	12.5 x 25	0.15	6.029	1.70	630	4.70	MALREKE00FG233N00K
	47	12.5 x 25	0.15	4.233	1.70	630	4.70	MALREKE00FG247N00K
	100	16 x 31.5	0.15	1.989	0.63	1400	9.00	MALREKE00JS310N00K
	150	18 x 31.5	0.15	1.326	0.42	1450	11.0	MALREKE00KS315N00K
	220	18 x 40	0.15	0.904	0.35	1485	15.0	MALREKE00KK322N00K
400	10	10 x 20	0.20	26.53	2.90	180	3.00	MALREKE00DE210X00K
	22	12.5 x 25	0.20	12.06	1.30	300	4.70	MALREKE00FG222X00K
	33	16 x 20	0.20	8.038	0.91	600	5.80	MALREKE00JE233X00K
	47	16 x 25	0.20	5.644	0.73	700	6.60	MALREKE00JG247X00K
	100	18 x 40	0.20	2.653	0.34	1250	15.0	MALREKE00KK310X00K
450	3.3	10 x 20	0.20	80.38	6.50	150	3.00	MALREKE00DE133P00K
	4.7	12.5 x 20	0.20	56.44	3.60	200	4.50	MALREKE00FE147P00K
	10	12.5 x 25	0.20	26.53	2.50	315	4.70	MALREKE00FG210P00K
	22	16 x 25	0.20	12.06	1.70	570	6.60	MALREKE00JG222P00K
	33	16 x 31.5	0.20	8.038	1.10	620	9.00	MALREKE00JS233P00K
	47	18 x 31.5	0.20	5.644	0.93	900	11.0	MALREKE00KS247P00K

LOW TEMPERATURE BEHAVIOR (at 120 Hz)

IMPEDANCE RATIO Z (T2)/Z (T1)	RATED VOLTAGE (V)					
T2/T1	6.3	10	16	25 ~ 100	160 ~ 250	350 ~ 450
- 25/+ 20 °C	4	3	2	2	3	8
- 40/+ 20 °C	8	6	4	3	4	-

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 1 minute at U_R	$I_{L1} \leq 0.03 \times C_R \times U_R$ or 4 µA for $U_R \leq 100$ V (whichever is greater)
	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA for $U_R \leq 100$ V (whichever is greater)
	After 5 minutes at U_R	$I_{L5} \leq 0.02 \times C_R \times U_R$ or 15 µA for $U_R > 100$ V (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R	ESR = tan $\delta/2 \pi f C_R$

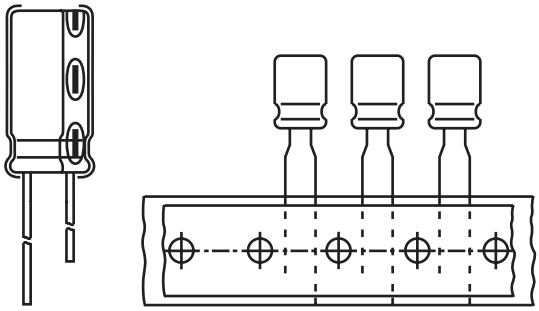
MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY

FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R \leq 100$ V		
	$C_R \leq 47$ µF	C_R = 68 to 680 µF	$C_R \geq 1000$ µF
50	0.34	0.47	0.65
120	0.45	0.59	0.77
300	0.61	0.74	0.85
1000	0.70	0.79	0.88
10 000	0.91	0.88	0.88
100 000	1.00	1.00	1.00

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R > 100$ V	
	C_R = 0.47 to 220 µF	$C_R \geq 330$ µF
50	0.44	0.69
120	0.56	0.77
300	0.69	0.87
1000	0.78	0.87
10 000	0.89	0.88
100 000	1.00	1.00

TEST PROCEDURES AND REQUIREMENTS		
TEST	PROCEDURE (quick reference)	REQUIREMENTS
Load life	T_{amb} = 105 °C U_R and I_R applied After specified hours	Δ C/C: ± 25 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit
Shelf life	T_{amb} = 105 °C No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 25 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit

Aluminum Capacitors
Radial Style



Component outlines

FEATURES

- Polarized aluminum electrolytic capacitor
- Small dimensions
- Ultra low impedance
- High ripple current
- Long lifetime

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Industrial electronics, telecommunication systems, data processing
- Professional switching power supply units
- DC/DC converters
- Smoothing, filtering

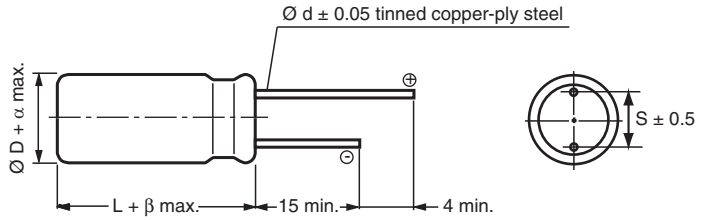
QUICK REFERENCE DATA		
DESCRIPTION	**UNIT**	**VALUE**
Nominal case size (Ø D x L)	mm	5 x 11 to 18 x 40
Rated capacitance range C_R	µF	0.47 to 15 000
Capacitance tolerance	%	± 20
Rated voltage range	V	6.3 to 100
Category temperature range	°C	- 40 to + 105
Load life	h	up to 5000
Based on sectional specification		IEC 60384-4/EN 130300
Climatic category IEC 68		40/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	RATED VOLTAGE (V)							
	6.3	**10**	**16**	**25**	**35**	**50**	**63**	**100**
0.47	→	→	→	→	→	5 x 11	-	-
1.0	→	→	→	→	→	5 x 11	-	-
2.2	→	→	→	→	→	5 x 11	→	5 x 11
3.3	→	→	→	→	→	5 x 11	5 x 11	5 x 11
4.7	→	→	→	→	5 x 11	5 x 11	5 x 11	5 x 11
10	→	→	→	→	5 x 11	5 x 11	5 x 11	6.3 x 11
22	→	→	→	→	5 x 11	5 x 11	6.3 x 11	8 x 11.5
33	→	→	→	→	5 x 11	6.3 x 11	6.3 x 11	10 x 12.5
47	→	→	→	5 x 11	→	6.3 x 11	8 x 11.5	10 x 16
100	→	5 x 11	→	6.3 x 11	→	8 x 11.5	10 x16	12.5 x 20
150	→	→	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 20	12.5 x 25
220	→	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16	10 x 25	16 x 25
330	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	16 x 31.5
470	→	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	16 x 20	18 x 40
1000	10 x 12.5	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 35.5	-
1500	→	10 x 20	12.5 x 20	16 x 20	16 x 25	16 x 31.5	-	-
2200	→	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5	18 x 35.5	-	-
3300	12.5 x 20	12.5 x 25	16 x 25	16 x 31.5	18 x 35.5	-	-	-
4700	→	16 x 25	16 x 31.5	18 x 35.5	-	-	-	-
10 000	16 x 31.5	18 x 35.5	-	-	-	-	-	-
15 000	18 x 35.5	-	-	-	-	-	-	-

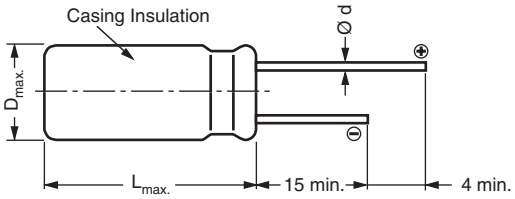
Note
10 % capacitance tolerance on request

RADIAL STYLE: DIMENSIONS in millimeters

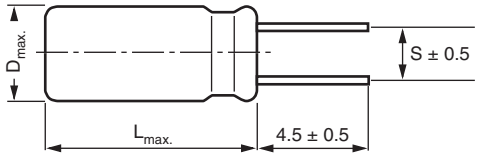


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

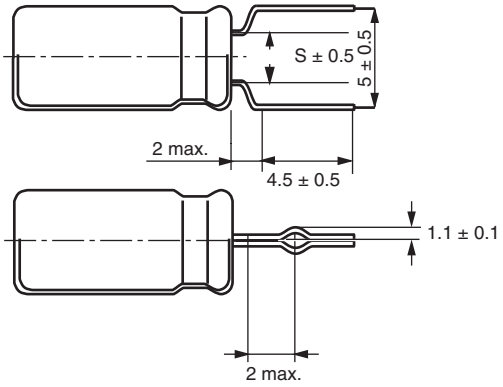
DIMENSIONS in millimeters AND AVAILABLE FORMS



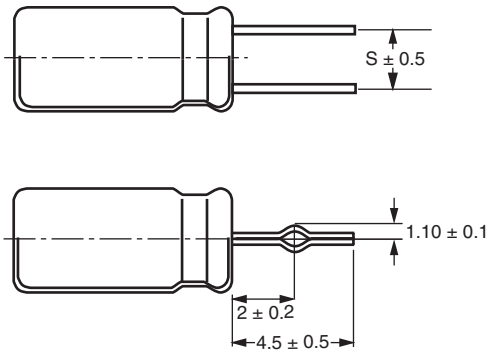
Ø D ≤ 18 long leads MALREKX00...



Ø D ≤ 18 shortened leads MALREKX05...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKX09...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKX06...
(S = 5/7.5 mm)

GENERAL NOTE

- For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service
- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
Z	max. impedance at 100 kHz
I_R	rated alternating current (rms) at 100 kHz and upper category temperature

Note

Unless otherwise specified, all electrical values at T_a = 20 °C, P = 80 to 120 kPa, RH = 45 to 75 %

ORDERING EXAMPLE

EKX 3300 µF/25 V, ± 20 %, size: 16 x 31.5 mm
Leads: Long
Ordering code: MALREKX00JS433E00K

Leads: Short
Ordering code: MALREKX05...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKX09...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKX06 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	Z 100 kHz/20 °C (Ω)	I_R 100 kHz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
6.3	330	6.3 x 11	0.22	0.15	405	0.67	MALREKX00BA333B00K
	1000	10 x 12.5	0.22	0.053	1030	1.90	MALREKX00DC410B00K
	3300	12.5 x 20	0.28	0.025	2360	4.00	MALREKX00FE433B00K
	10 000	16 x 31.5	0.40	0.015	3680	9.00	MALREKX00JS510B00K
	15 000	18 x 35.5	0.50	0.014	3800	11.5	MALREKX00KL515B00K
10	100	5 x 11	0.19	0.30	250	0.42	MALREKX00AA310C00K
	220	6.3 x 11	0.19	0.15	405	0.67	MALREKX00BA322C00K
	470	8 x 11.5	0.19	0.072	760	1.10	MALREKX00PB347C00K
	1000	10 x 16	0.19	0.038	1430	2.50	MALREKX00DD410C00K
	1500	10 x 20	0.21	0.027	1820	3.10	MALREKX00DE415C00K
	2200	12.5 x 20	0.23	0.025	2360	4.00	MALREKX00FE422C00K
	3300	12.5 x 25	0.25	0.018	2770	5.20	MALREKX00FG433C00K
	4700	16 x 25	0.27	0.015	3460	7.70	MALREKX00JG447C00K
	10 000	18 x 35.5	0.39	0.014	3800	11.5	MALREKX00KL510C00K
16	150	6.3 x 11	0.16	0.15	405	0.67	MALREKX00BA315D00K
	330	8 x 11.5	0.16	0.072	760	1.10	MALREKX00PB333D00K
	470	10 x 12.5	0.16	0.053	1030	1.90	MALREKX00DC347D00K
	1000	10 x 20	0.16	0.027	1820	3.10	MALREKX00DE410D00K
	1500	12.5 x 20	0.18	0.025	2360	4.00	MALREKX00FE415D00K
	2200	12.5 x 25	0.20	0.018	2770	5.20	MALREKX00FG422D00K
	3300	16 x 25	0.22	0.015	3460	7.70	MALREKX00JG433D00K
	4700	16 x 31.5	0.24	0.015	3680	9.00	MALREKX00JS447D00K
25	47	5 x 11	0.14	0.30	250	0.42	MALREKX00AA247E00K
	100	6.3 x 11	0.14	0.15	405	0.67	MALREKX00BA310E00K
	220	8 x 11.5	0.14	0.072	760	1.10	MALREKX00PB322E00K
	330	10 x 12.5	0.14	0.053	1030	1.90	MALREKX00DC333E00K
	470	10 x 16	0.14	0.038	1430	2.50	MALREKX00DD347E00K
	1000	12.5 x 20	0.14	0.025	2360	4.00	MALREKX00FE410E00K
	1500	16 x 20	0.16	0.015	3460	6.10	MALREKX00JE415E00K
	2200	16 x 25	0.18	0.015	3460	7.70	MALREKX00JG422E00K
	3300	16 x 31.5	0.20	0.015	3680	9.00	MALREKX00JS433E00K
	4700	18 x 35.5	0.22	0.014	3800	11.5	MALREKX00KL447E00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	Z 100 kHz/20 °C (Ω)	I_R 100 kHz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
35	4.7	5 x 11	0.12	0.35	250	0.42	MALREKX00AA147F00K
	10	5 x 11	0.12	0.35	250	0.42	MALREKX00AA210F00K
	22	5 x 11	0.12	0.35	250	0.42	MALREKX00AA222F00K
	33	5 x 11	0.12	0.30	250	0.42	MALREKX00AA233F00K
	150	8 x 11.5	0.12	0.072	760	1.10	MALREKX00PB315F00K
	220	10 x 12.5	0.12	0.053	1030	1.90	MALREKX00DC322F00K
	330	10 x 16	0.12	0.038	1430	2.50	MALREKX00DD333F00K
	470	10 x 20	0.12	0.027	1820	3.10	MALREKX00DE347F00K
	1000	12.5 x 25	0.12	0.018	2770	5.20	MALREKX00FG410F00K
	1500	16 x 25	0.14	0.015	3460	7.70	MALREKX00JG415F00K
	2200	16 x 31.5	0.16	0.015	3680	9.00	MALREKX00JS422F00K
	3300	18 x 35.5	0.18	0.014	3680	11.5	MALREKX00KL433F00K
50	0.47	5 x 11	0.10	2.0	250	0.42	MALREKX00AA047H00K
	1.0	5 x 11	0.10	2.0	250	0.42	MALREKX00AA110H00K
	2.2	5 x 11	0.10	2.0	250	0.42	MALREKX00AA122H00K
	3.3	5 x 11	0.10	1.0	250	0.42	MALREKX00AA133H00K
	4.7	5 x 11	0.10	1.0	250	0.42	MALREKX00AA147H00K
	10	5 x 11	0.10	0.50	250	0.42	MALREKX00AA210H00K
	22	5 x 11	0.10	0.26	250	0.42	MALREKX00AA222H00K
	33	6.3 x 11	0.10	0.17	405	0.67	MALREKX00BA233H00K
	47	6.3 x 11	0.10	0.14	405	0.67	MALREKX00BA247H00K
	100	8 x 11.5	0.10	0.072	760	1.10	MALREKX00PB310H00K
	150	10 x 12.5	0.10	0.061	1030	1.90	MALREKX00DC315H00K
	220	10 x 16	0.10	0.038	1430	2.50	MALREKX00DD322H00K
	330	10 x 20	0.10	0.032	1820	3.10	MALREKX00DE333H00K
	470	12.5 x 20	0.10	0.025	2360	4.00	MALREKX00FE347H00K
	1000	16 x 25	0.10	0.018	3460	7.70	MALREKX00JG410H00K
	1500	16 x 31.5	0.12	0.015	3680	9.00	MALREKX00JS415H00K
	2200	18 x 35.5	0.14	0.014	3800	11.5	MALREKX00KL422H00K
63	3.3	5 x 11	0.09	2.0	165	0.42	MALREKX00AA133J00K
	4.7	5 x 11	0.09	2.0	165	0.42	MALREKX00AA147J00K
	10	5 x 11	0.09	0.45	165	0.42	MALREKX00AA210J00K
	22	6.3 x 11	0.09	0.30	265	0.67	MALREKX00BA222J00K
	33	6.3 x 11	0.09	0.30	265	0.67	MALREKX00BA233J00K
	47	8 x 11.5	0.09	0.20	500	1.10	MALREKX00PB247J00K
	100	10 x 16	0.09	0.10	945	2.50	MALREKX00DD310J00K
	150	10 x 20	0.09	0.08	1100	3.10	MALREKX00DE315J00K
	220	10 x 25	0.09	0.07	1300	2.40	MALREKX00DG322J00K
	330	12.5 x 20	0.09	0.04	1495	4.00	MALREKX00FE333J00K
	470	16 x 20	0.09	0.035	1990	6.10	MALREKX00JE347J00K
	1000	16 x 35.5	0.09	0.020	2835	11.0	MALREKX00JL410J00K
100	2.2	5 x 11	0.08	2.0	125	0.42	MALREKX00AA122L00K
	3.3	5 x 11	0.08	2.0	125	0.42	MALREKX00AA133L00K
	4.7	5 x 11	0.08	2.0	125	0.42	MALREKX00AA147L00K
	10	6.3 x 11	0.08	0.50	205	0.67	MALREKX00BA210L00K
	22	8 x 11.5	0.08	0.30	355	1.10	MALREKX00PB222L00K
	33	10 x 12.5	0.08	0.25	450	1.90	MALREKX00DC233L00K
	47	10 x 16	0.08	0.20	580	2.50	MALREKX00DD247L00K
	100	12.5 x 20	0.08	0.10	1045	4.00	MALREKX00FE310L00K
	150	12.5 x 25	0.08	0.070	1195	5.20	MALREKX00FG315L00K
	220	16 x 25	0.08	0.060	1600	7.70	MALREKX00JG322L00K
	330	16 x 31.5	0.08	0.040	1750	9.00	MALREKX00JS333L00K
	470	18 x 40	0.08	0.030	2060	15.0	MALREKX00KK347L00K

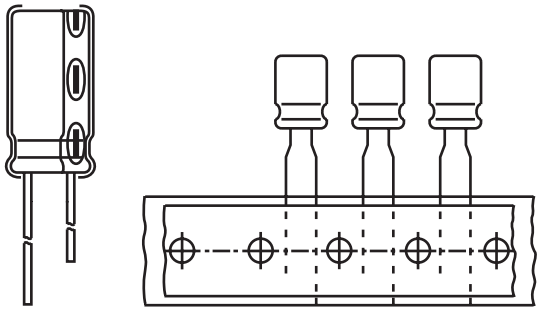
LOW TEMPERATURE BEHAVIOR (at 120 Hz)				
IMPEDANCE RATIO Z (T2)/Z (T1)	RATED VOLTAGE (V)			
T2/T1	6.3	10	16	25 ~ 100
- 25 °C/+ 20 °C	2	2	2	2
- 40 °C/+ 20 °C	3	3	3	3

ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
Current			
Leakage current	After 1 minute at U_R	$I_{L1} \leq 0.03 \times C_R \times U_R$	or 4 µA (whichever is greater)
(Test conditions: U_R, 20 °C)	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$	or 3 µA (whichever is greater)
Resistance			
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta/2\ \pi\ f\ C_R$	

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY					
FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R \leq 100$ V				
	~ 33 µF	47 ~ 220 µF	330 ~ 680 µF	1000 ~ 1500 µF	2200 ~ 15 000 µF
120	0.42	0.50	0.55	0.60	0.70
1000	0.70	0.73	0.77	0.80	0.85
10 000	0.90	0.92	0.94	0.96	0.98
≥ 100 000	1.00	1.00	1.00	1.00	1.00

TEST PROCEDURES AND REQUIREMENTS		
TEST	PROCEDURE (quick reference)	REQUIREMENTS
Load life	T_{amb} = 105 °C U_R and I_R applied After 2000 hours Ø 5, Ø 6.3 After 3000 hours Ø 8 mm After 4000 hours Ø 10 mm After 5000 hours > Ø 10 mm	Δ C/C: ± 25 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit
Shelf life	No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 25 % of initial value $I_L \leq$ spec.limit tan $\delta \leq 2$ x spec. limit

Aluminum Capacitors
Radial Style



Component outlines

FEATURES

- Polarized aluminum electrolytic capacitor
- High ripple current
- High reliability
- High load life up to 10 000 h

Pb-free

RoHS COMPLIANT

APPLICATIONS

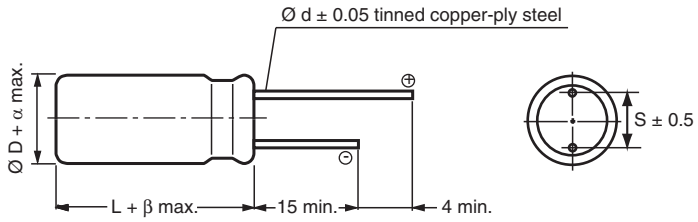
- For electronic lighting ballast
- Power supply

QUICK REFERENCE DATA		
DESCRIPTION	**UNIT**	**VALUE**
Nominal case size (Ø D x L)	mm	10 x 12.5 to 18 x 31.5
Rated capacitance range C_R	µF	1.0 to 150
Capacitance tolerance	%	± 20
Rated voltage range	V	200 to 450
Category temperature range	°C	- 25 to 105
Load life	h	10 000
Based on sectional specification		IEC 60384-4/EN130300
Climatic category IEC 60 068		25/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

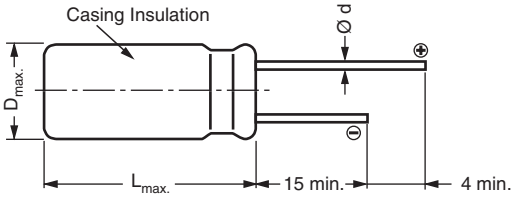
C_R (µF)	RATED VOLTAGE (V)				
	200	**250**	**350**	**400**	**450**
1.0	→	→	→	10 x 12.5	-
2.2	→	→	→	10 x 12.5	10 x 16
3.3	→	→	10 x 12.5	→	10 x 16
4.7	→	→	→	10 x 16	10 x 20
6.8	→	10 x 12.5	→	10 x 16	10 x 20
10	10 x 16	→	→	10 x 20	12.5 x 20
22	10 x 20	→	12.5 x 20	12.5 x 25	16 x 25
33	→	12.5 x 20	16 x 20	16 x 25	18 x 25
47	12.5 x 20	12.5 x 25	16 x 25	18 x 25	18 x 31.5
68	12.5 x 25	16 x 25	18 x 25	-	-
100	16 x 25	18 x 25	-	-	-
150	18 x 25	-	-	-	-

RADIAL STYLE: DIMENSIONS in millimeters

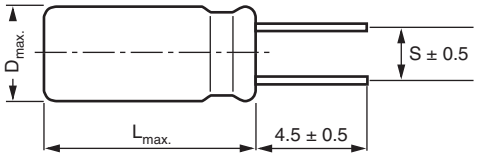


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

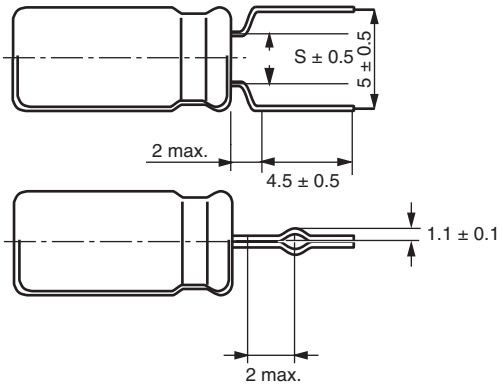
DIMENSIONS in millimeters AND AVAILABLE FORMS



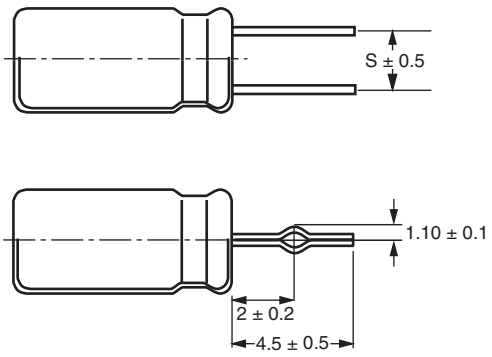
Ø D ≤ 18 long leads MALREKV00...



Ø D ≤ 18 shortened leads MALREKV05...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKV09...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKV06...
(S = 5/7.5 mm)

GENERAL NOTE

- For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service
- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	max. equivalent series resistance at 120 Hz
I_R	rated alternating current (rms) at 120 Hz and upper category temperature

Note

Unless otherwise specified, all electrical values apply at T_{amb} = 20 °C, P = 80 to 120 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

EKV 22 µF/450 V, ± 20 %, size: 16 x 25 mm
Leads: Long
Ordering code: MALREKV00JG222P00K

Leads: Short
Ordering code: MALREKV05...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKV09...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKV06 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 100 kHz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
200	10	10 x 16	0.15	19.9	250	2.3	MALREKV00DD210S00K
	22	10 x 20	0.15	9.04	500	2.8	MALREKV00DE222S00K
	47	12.5 x 20	0.15	4.23	660	3.8	MALREKV00FE247S00K
	68	12.5 x 25	0.15	2.93	760	5.1	MALREKV00FG268S00K
	100	16 x 25	0.15	1.99	1120	7.1	MALREKV00JG310S00K
	150	18 x 25	0.15	1.33	1360	9.5	MALREKV00KG315S00K
250	6.8	10 x 12.5	0.15	29.3	120	1.9	MALREKV00DC168N00K
	33	12.5 x 20	0.15	6.03	600	3.8	MALREKV00FE233N00K
	47	12.5 x 25	0.15	4.23	720	5.1	MALREKV00FG247N00K
	68	16 x 25	0.15	2.93	920	7.1	MALREKV00JG268N00K
	100	18 x 25	0.15	1.99	1200	9.5	MALREKV00KG310N00K
350	3.3	10 x 12.5	0.20	80.4	100	1.9	MALREKV00DC133O00K
	22	12.5 x 20	0.20	12.1	350	3.8	MALREKV00FE222O00K
	33	16 x 20	0.20	8.04	500	6.3	MALREKV00JE233O00K
	47	16 x 25	0.20	5.64	660	7.1	MALREKV00JG247O00K
	68	18 x 25	0.20	3.90	840	9.5	MALREKV00KG268O00K
400	1.0	10 x 12.5	0.24	318	90	1.9	MALREKV00DC110X00K
	2.2	10 x 12.5	0.24	145	100	1.9	MALREKV00DC122X00K
	4.7	10 x 16	0.24	67.7	180	2.3	MALREKV00DD147X00K
	6.8	10 x 16	0.24	46.8	200	2.3	MALREKV00DD168X00K
	10	10 x 20	0.20	26.5	280	2.8	MALREKV00DE210X00K
	22	12.5 x 25	0.20	12.1	430	5.1	MALREKV00FG222X00K
	33	16 x 25	0.20	8.04	640	7.1	MALREKV00JG233X00K
	47	18 x 25	0.20	5.64	840	9.5	MALREKV00KG247X00K
450	2.2	10 x 16	0.24	145	120	2.3	MALREKV00DD122P00K
	3.3	10 x 16	0.24	96.5	140	2.3	MALREKV00DD133P00K
	4.7	10 x 20	0.24	67.7	180	2.8	MALREKV00DE147P00K
	6.8	10 x 20	0.24	46.8	200	2.8	MALREKV00DE168P00K
	10	12.5 x 20	0.20	26.5	320	3.8	MALREKV00FE210P00K
	22	16 x 25	0.20	12.1	560	7.1	MALREKV00JG222P00K
	33	18 x 25	0.20	8.04	700	9.5	MALREKV00KG233P00K
	47	18 x 31.5	0.20	5.64	880	12.0	MALREKV00KS247P00K

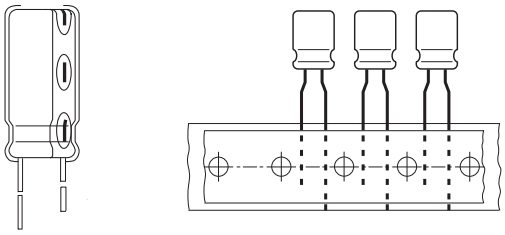
LOW TEMPERATURE BEHAVIOUR (AT 120 Hz)					
IMPEDANCE RATIO Z(T2) Z(T1) AT 120 Hz	RATED VOLTAGE (V)				
T2/T1	200	250	350	400	450
- 25 °C/+ 20 °C	3	3	4	6	6

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 5 minutes at U_R	$I_{L5} \leq 0.02 \times C_R \times U_R + 25\ \mu A$
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta / 2 \pi f C_R$

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	I_R MULTIPLIER	
	1.0 ~ 4.7 µF	6.8 ~ 150 µF
60	0.25	0.35
120	0.30	0.50
300	0.45	0.60
1000	0.60	0.80
10 000	0.80	0.90
≥ 100 000	1.00	1.00

TEST PROCEDURES AND REQUIREMENTS		
TEST	PROCEDURE (quick reference)	REQUIREMENTS
Load life	T_{amb} = 105 °C U_R and I_R applied After 5000 hours ≤ 6.8 µF After 10 000 hours ≥ 10 µF	Δ C/C: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq$ 2 x spec. limit
Shelf life	No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 20 % of initial value $I_L \leq$ spec.limit tan $\delta \leq$ 2 x spec. limit

Aluminum Capacitors
Radial Style 125 °C



Component outlines

FEATURES

- Polarized aluminum electrolytic capacitor
- Long lifetime
- High temperature range up to 125 °C
- Low impedance
- High reliability

Pb-free

RoHS COMPLIANT

APPLICATIONS

- Industrial electronics, automotive electronics, data processing electronics, telecommunication systems
- Smoothing, filtering

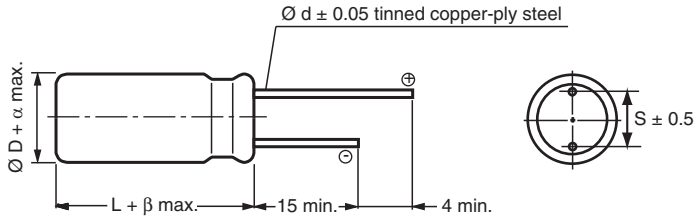
QUICK REFERENCE DATA

DESCRIPTION	UNIT	VALUE	
Nominal case size (Ø D x L)	mm	5 x 11 to 18 x 40	
Rated capacitance range C_R	µF	0.47 to 10 000	
Capacitance tolerance	%	± 20	
Rated voltage range	V	10 to 50	63 to 250
Category temperature range	°C	- 55 to + 125	- 40 to + 125
Load life	h	up to 2000	
Based on sectional specification		IEC 60384-4/EN 130 300	
Climatic category IEC 60068		55/125/56	40/125/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

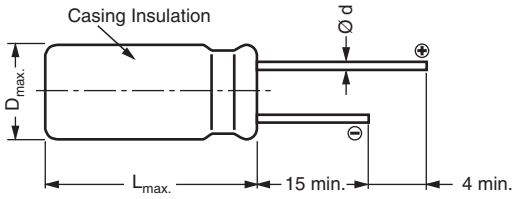
C_R (µF)	RATED VOLTAGE [V]									
	10	16	25	35	50	63	100	160	200	250
0.47	→	→	→	→	→	→	8 x 11.5	10 x 12.5	→	10 x 12.5
1.0	→	→	→	→	5 x 11	→	8 x 11.5	10 x 12.5	→	10 x 12.5
1.5	→	→	→	→	5 x 11	→	→	→	→	→
2.2	→	→	→	→	5 x 11	8 x 11.5	10 x 12.5	10 x 16	→	10 x 16
3.3	→	→	→	→	5 x 11	8 x 11.5	10 x 16	10 x 16	→	10 x 20
4.7	→	→	→	→	5 x 11	8 x 11.5	10 x 16	10 x 20	10 x 20	12.5 x 20
6.8	→	→	→	→	5 x 11	→	→	→	→	→
10	→	→	→	→	5 x 11	8 x 11.5	10 x 20	12.5 x 20	12.5 x 20	16 x 25
15	→	→	→	→	5 x 11	-	-	-	-	-
22	→	→	→	5 x 11	6.3 x 11	10 x 16	12.5 x 25	16 x 25	16 x 31.5	-
33	→	→	5 x 11	→	6.3 x 11	10 x 20	16 x 25	16 x 31.5	-	-
47	→	5 x 11	→	6.3 x 11	8 x 11.5	12.5 x 20	16 x 31.5	-	-	-
68	5 x 11	→	6.3 x 11	→	8 x 11.5	-	-	-	-	-
100	→	6.3 x 11	→	8 x 11.5	10 x 16	12.5 x 25	-	-	-	-
150	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 20	-	-	-	-	-
220	→	8 x 11.5	10 x 12.5	10 x 16	10 x 25	-	-	-	-	-
330	8 x 11.5	10 x 12.5	10 x 16	10 x 20	12.5 x 20	-	-	-	-	-
470	10 x 12.5	10 x 16	10 x 20	12.5 x 20	12.5 x 25	-	-	-	-	-
680	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 20	-	-	-	-	-
1000	10 x 20	12.5 x 20	12.5 x 25	16 x 20	16 x 31.5	-	-	-	-	-
1500	12.5 x 20	12.5 x 25	16 x 20	16 x 31.5	16 x 40	-	-	-	-	-
2200	12.5 x 25	16 x 20	16 x 25	16 x 35.5	18 x 40	-	-	-	-	-
3300	16 x 20	16 x 25	16 x 35.5	18 x 40	-	-	-	-	-	-
4700	16 x 31.5	16 x 35.5	18 x 40	-	-	-	-	-	-	-
6800	16 x 35.5	18 x 35.5	-	-	-	-	-	-	-	-
10 000	18 x 40	-	-	-	-	-	-	-	-	-

RADIAL STYLE: DIMENSIONS in millimeters

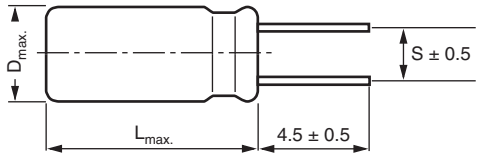


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

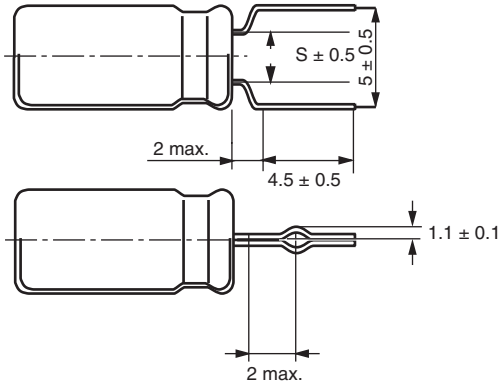
DIMENSIONS in millimeters AND AVAILABLE FORMS



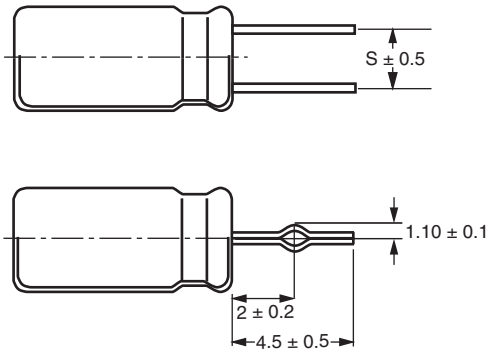
Ø D ≤ 18 long leads MALREKL00...



Ø D ≤ 18 shortened leads MALREKL05...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKL09...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKL06...
(S = 5/7.5 mm)

GENERAL NOTE

- For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service
- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
Z	max. impedance at 100 kHz
I_R	rated alternating current (rms) at 100 kHz and upper category temperature

Note

Unless otherwise specified, all electrical values at $T_a = 20$ °C, P = 80 to 120 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

EKL 100 µF/50 V, ± 20 %, size: 10 x 16 mm
Leads: Long
Ordering code: MALREKL00DD310H00K

Leads: Short
Ordering code: MALREKL05...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKL09...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKL06 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	Z 100 kHz/ 120 °C (Ω)	I_R 100 kHz/ 125 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
10	68	5 x 11	0.19	1.00	124	0.50	MALREKL00AA268C00K
	150	6.3 x 11	0.19	0.45	212	0.70	MALREKL00BA315C00K
	330	8 x 11.5	0.19	0.21	368	1.10	MALREKL00PB333C00K
	470	10 x 12.5	0.19	0.17	480	1.60	MALREKL00DC347C00K
	680	10 x 16	0.19	0.12	616	2.30	MALREKL00DD368C00K
	1000	10 x 20	0.19	0.078	848	2.50	MALREKL00DE410C00K
	1500	12.5 x 20	0.21	0.059	1134	3.80	MALREKL00FE415C00K
	2200	12.5 x 25	0.23	0.044	1368	4.50	MALREKL00FG422C00K
	3300	16 x 20	0.25	0.040	1480	5.80	MALREKL00JE433C00K
	4700	16 x 31.5	0.27	0.030	1936	9.00	MALREKL00JS447C00K
	6800	16 x 35.5	0.31	0.026	2144	11.0	MALREKL00JL468C00K
	10000	18 x 40	0.37	0.022	2432	16.0	MALREKL00KK510C00K
16	47	5 x 11	0.16	1.00	124	0.50	MALREKL00AA247D00K
	100	6.3 x 11	0.16	0.45	212	0.70	MALREKL00BA310D00K
	220	8 x 11.5	0.16	0.21	368	1.10	MALREKL00PB322D00K
	330	10 x 12.5	0.16	0.16	500	1.60	MALREKL00DC333D00K
	470	10 x 16	0.16	0.12	616	2.30	MALREKL00DD347D00K
	680	10 x 20	0.16	0.085	816	2.50	MALREKL00DE368D00K
	1000	12.5 x 20	0.16	0.061	1129	3.80	MALREKL00FE410D00K
	1500	12.5 x 25	0.18	0.047	1328	4.50	MALREKL00FG415D00K
	2200	16 x 20	0.20	0.043	1440	5.80	MALREKL00JE422D00K
	3300	16 x 25	0.22	0.035	1676	7.50	MALREKL00JG433D00K
	4700	16 x 35.5	0.24	0.026	2144	11.0	MALREKL00JL447D00K
	6800	18 x 35.5	0.28	0.023	2320	13.0	MALREKL00KL468D00K
25	33	5 x 11	0.14	1.00	124	0.50	MALREKL00AA233E00K
	68	6.3 x 11	0.14	0.47	208	0.70	MALREKL00BA268E00K
	150	8 x 11.5	0.14	0.21	368	1.10	MALREKL00PB315E00K
	220	10 x 12.5	0.14	0.17	480	1.60	MALREKL00DC322E00K
	330	10 x 16	0.14	0.12	600	2.30	MALREKL00DD333E00K
	470	10 x 20	0.14	0.084	816	2.50	MALREKL00DE347E00K
	680	12.5 x 20	0.14	0.060	1114	3.80	MALREKL00FE368E00K
	1000	12.5 x 25	0.14	0.047	1328	4.50	MALREKL00FG410E00K
	1500	16 x 20	0.16	0.044	1416	5.80	MALREKL00JE415E00K
	2200	16 x 25	0.18	0.036	1641	7.50	MALREKL00JG422E00K
	3300	16 x 35.5	0.20	0.026	2144	11.0	MALREKL00JL433E00K
	4700	18 x 40	0.22	0.023	2368	16.0	MALREKL00KK447E00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	Z 100 kHz/ 120 °C (Ω)	I_R 100 kHz/ 125 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
35	22	5 x 11	0.12	0.97	128	0.50	MALREKL00AA222F00K
	47	6.3 x 11	0.12	0.44	216	0.70	MALREKL00BA247F00K
	100	8 x 11.5	0.12	0.21	368	1.10	MALREKL00PB310F00K
	150	10 x 12.5	0.12	0.16	500	1.60	MALREKL00DC315F00K
	220	10 x 16	0.12	0.12	616	2.30	MALREKL00DD322F00K
	330	10 x 20	0.12	0.078	848	2.50	MALREKL00DE333F00K
	470	12.5 x 20	0.12	0.060	1121	3.80	MALREKL00FE347F00K
	680	12.5 x 25	0.12	0.047	1328	4.50	MALREKL00FG368F00K
	1000	16 x 20	0.12	0.044	1416	5.80	MALREKL00JE410F00K
	1500	16 x 31.5	0.14	0.036	1908	9.00	MALREKL00JS415F00K
	2200	16 x 35.5	0.16	0.026	2144	11.0	MALREKL00JL422F00K
	3300	18 x 40	0.18	0.022	2432	16.0	MALREKL00KK433F00K
50	1.0	5 x 11	0.10	5.20	29	0.50	MALREKL00AA110H00K
	1.5	5 x 11	0.10	4.90	36	0.50	MALREKL00AA115H00K
	2.2	5 x 11	0.10	4.50	43	0.50	MALREKL00AA122H00K
	3.3	5 x 11	0.10	3.90	53	0.50	MALREKL00AA133H00K
	4.7	5 x 11	0.10	2.90	65	0.50	MALREKL00AA147H00K
	6.8	5 x 11	0.10	2.30	73	0.50	MALREKL00AA168H00K
	10	5 x 11	0.10	1.80	92	0.50	MALREKL00AA210H00K
	15	5 x 11	0.10	1.20	116	0.50	MALREKL00AA215H00K
	22	6.3 x 11	0.10	0.84	156	0.70	MALREKL00BA222H00K
	33	6.3 x 11	0.10	0.56	192	0.70	MALREKL00BA233H00K
	47	8 x 11.5	0.10	0.39	275	1.10	MALREKL00PB247H00K
	68	8 x 11.5	0.10	0.26	328	1.10	MALREKL00PB268H00K
	100	10 x 16	0.10	0.21	465	2.30	MALREKL00DD310H00K
	150	10 x 20	0.10	0.13	656	2.50	MALREKL00DE315H00K
	220	10 x 25	0.10	0.098	832	3.00	MALREKL00DG322H00K
	330	12.5 x 20	0.10	0.072	1025	3.80	MALREKL00FE333H00K
	470	12.5 x 25	0.10	0.057	1200	4.50	MALREKL00FG347H00K
	680	16 x 20	0.10	0.052	1304	5.80	MALREKL00JE368H00K
	1000	16 x 31.5	0.10	0.039	1696	9.00	MALREKL00JS410H00K
	1500	16 x 40	0.12	0.034	1928	13.0	MALREKL00JK415H00K
	2200	18 x 40	0.14	0.031	2048	16.0	MALREKL00KK422H00K
63	2.2	8 x 11.5	0.08	4.00	28	1.10	MALREKL00PB122J00K
	3.3	8 x 11.5	0.08	3.50	34	1.10	MALREKL00PB133J00K
	4.7	8 x 11.5	0.08	2.60	41	1.10	MALREKL00PB147J00K
	10	8 x 11.5	0.08	2.20	60	1.10	MALREKL00PB210J00K
	22	10 x 16	0.08	1.00	113	2.30	MALREKL00DD222J00K
	33	10 x 20	0.08	0.70	151	2.50	MALREKL00DE233J00K
	47	12.5 x 20	0.08	0.60	211	3.80	MALREKL00FE247J00K
	100	12.5 x 25	0.08	0.20	336	4.50	MALREKL00FG310J00K
100	0.47	8 x 11.5	0.08	6.00	13	1.10	MALREKL00PB047L00K
	1.0	8 x 11.5	0.08	5.00	19	1.10	MALREKL00PB110L00K
	2.2	10 x 12.5	0.08	3.80	33	1.60	MALREKL00DC122L00K
	3.3	10 x 16	0.08	3.30	44	2.30	MALREKL00DD133L00K
	4.7	10 x 16	0.08	2.50	52	2.30	MALREKL00DD147L00K
	10	10 x 20	0.08	2.00	83	2.50	MALREKL00DE210L00K
	22	12.5 x 25	0.08	1.00	157	4.50	MALREKL00FG222L00K
	33	16 x 25	0.08	0.70	214	7.50	MALREKL00JG233L00K
	47	16 x 31.5	0.08	0.60	279	9.00	MALREKL00JS247L00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	Z 100 kHz/ 120 °C (Ω)	I_R 100 kHz/ 125 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
160	0.47	10 x 12.5	0.15	6.00	10	1.60	MALREKL00DC047M00K
	1.0	10 x 12.5	0.15	5.00	15	1.60	MALREKL00DC110M00K
	2.2	10 x 16	0.15	3.80	24	2.30	MALREKL00DD122M00K
	3.3	10 x 16	0.15	3.50	32	2.30	MALREKL00DD133M00K
	4.7	10 x 20	0.15	2.50	38	2.50	MALREKL00DE147M00K
	10	12.5 x 20	0.15	2.00	66	3.80	MALREKL00FE210M00K
	22	16 x 25	0.15	1.20	118	7.50	MALREKL00JG222M00K
	33	16 x 31.5	0.15	1.00	158	9.00	MALREKL00JS233M00K
200	4.7	10 x 20	0.15	2.80	38	2.50	MALREKL00DE147S00K
	10	12.5 x 20	0.15	2.50	72	3.80	MALREKL00FE210S00K
	22	16 x 31.5	0.15	2.00	129	9.00	MALREKL00JS222S00K
250	0.47	10 x 12.5	0.15	8.00	10	1.60	MALREKL00DC047N00K
	1.0	10 x 12.5	0.15	7.00	14	1.60	MALREKL00DC110N00K
	2.2	10 x 16	0.15	5.50	24	2.30	MALREKL00DD122N00K
	3.3	10 x 20	0.15	4.50	32	2.50	MALREKL00DE133N00K
	4.7	12.5 x 20	0.15	4.10	45	3.80	MALREKL00FE147N00K
	10	16 x 25	0.15	3.90	79	7.50	MALREKL00JG210N00K

LOW TEMPERATURE BEHAVIOR (AT 120 Hz)

IMPEDANCE RATIO Z(T2)/Z(T1)	RATED VOLTAGE (V)	
T2/T1	10	16 - 250
- 25/- 20 °C	3	2
- 40/+ 20 °C	5	4

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Current		
Leakage current (Test conditions: U_R, 20 °C)		
	After 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA for $U_R \leq 50$ V (whichever is greater)
	After 5 minutes at U_R	$I_{L5} \leq 0.03 \times C_R \times U_R$ + 10 µA for $U_R \geq 63$ V
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta / 2 \pi f C_R$

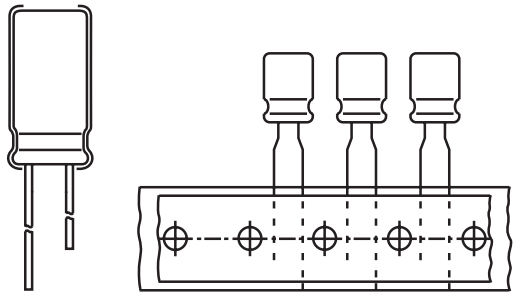
MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY

FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R \leq 50$ V					
	$C_R \leq 33$ µF	C_R = 47 to 100 µF	C_R = 150 to 220 µF	C_R = 330 to 680 µF	C_R = 1000 to 1500 µF	$C_R \geq 2200$ µF
120	0.20	0.25	0.35	0.45	0.50	0.55
1000	0.50	0.60	0.70	0.75	0.80	0.85
10 000	0.80	0.90	0.92	0.95	0.96	0.98
100 000	1.00	1.00	1.00	1.00	1.00	1.00

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER FOR $U_R \geq 63$ V**
120	0.56
1000	0.78
10 000	0.89
100 000	1.00

TEST PROCEDURES AND REQUIREMENTS		
TEST	**PROCEDURE (quick reference)**	**REQUIREMENTS**
Load life	T_{amb} = 125 °C U_R and I_R applied After 2000 hours After 1000 hours Ø 5, Ø 6.3 and $U_R \geq 100$ V	Δ C/C: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 3$ x spec. limit
Shelf life	No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 20 % of initial value $I_L \leq$ spec.limit tan $\delta \leq 2$ x spec. limit

Aluminum Capacitors
Radial Style Non-Polar



Component outlines

FEATURES

- Non-polarized (bi-polar) aluminum electrolytic capacitor
- Small size
- High temperature range

Pb-free

RoHS
COMPLIANT

APPLICATIONS

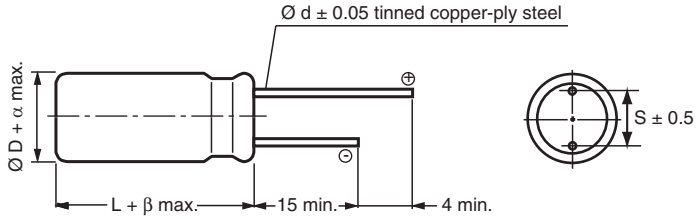
- Circuits with changing or unknown polarity

QUICK REFERENCE DATA		
DESCRIPTION	**UNIT**	**VALUE**
Nominal case size (Ø D x L)	mm	5 x 11 to 18 x 40
Rated capacitance range C_R	µF	0.1 to 4700
Capacitance tolerance	%	± 20
Rated voltage range	V	6.3 to 100
Category temperature range	°C	- 40 to + 105
Load life	h	1000
Based on sectional specification		IEC 60384-4
Climatic category IEC 60 068		40/105/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

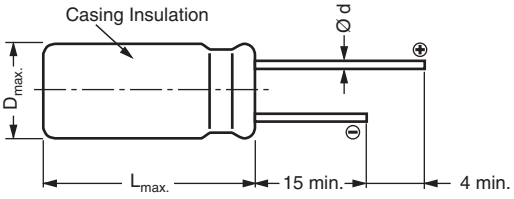
C_R (µF)	RATED VOLTAGE (V)							
	6.3	**10**	**16**	**25**	**35**	**50**	**63**	**100**
0.10	→	→	→	→	→	→	5 x 11	5 x 11
0.15	→	→	→	→	→	→	5 x 11	5 x 11
0.22	→	→	→	→	→	→	5 x 11	5 x 11
0.33	→	→	→	→	→	→	5 x 11	5 x 11
0.47	→	→	→	→	→	→	5 x 11	5 x 11
0.68	→	→	→	→	→	→	5 x 11	5 x 11
1.0	→	→	→	→	→	→	5 x 11	5 x 11
1.5	→	→	→	→	→	→	5 x 11	5 x 11
2.2	→	→	→	→	→	→	5 x 11	-
3.3	→	→	→	→	→	→	5 x 11	6.3 x 11
4.7	→	→	→	→	→	→	6.3 x 11	-
6.8	→	→	→	→	5 x 11	→	6.3 x 11	10 x 12.5
10	→	→	→	→	→	6.3 x 11	8 x 11.5	10 x 12.5
15	→	→	5 x 11	6.3 x 11	→	8 x 11.5	10 x 12.5	10 x 16
22	→	5 x 11	6.3 x 11	→	8 x 11.5	→	10 x 16	-
33	5 x 11	6.3 x 11	→	8 x 11.5	10 x 12.5	→	10 x 16	-
47	→	6.3 x 11	8 x 11.5	→	10 x 16	→	10 x 20	-
68	6.3 x 11	8 x 11.5	10 x 12.5	10 x 16	→	10 x 20	12.5 x 20	-
100	8 x 11.5	10 x 12.5	10 x 16	→	10 x 20	12.5 x 20	12.5 x 25	-
150	10 x 12.5	10 x 16	10 x 20	→	12.5 x 20	12.5 x 25	16 x 25	-
220	10 x 12.5	10 x 20	→	12.5 x 20	12.5 x 25	16 x 25	16 x 35.5	-
330	10 x 16	→	12.5 x 20	12.5 x 25	16 x 25	16 x 35.5	18 x 35.5	-
470	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 35.5	18 x 35.5	18 x 40	-
680	12.5 x 20	12.5 x 25	16 x 25	16 x 35.5	18 x 35.5	18 x 40	-	-
1000	12.5 x 25	16 x 25	16 x 35.5	18 x 35.5	18 x 40	-	-	-
1500	16 x 25	16 x 35.5	18 x 35.5	18 x 40	-	-	-	-
2200	16 x 35.5	18 x 35.5	18 x 40	-	-	-	-	-
3300	18 x 35.5	18 x 40	-	-	-	-	-	-
4700	18 x 40	-	-	-	-	-	-	-

RADIAL STYLE: DIMENSIONS in millimeters

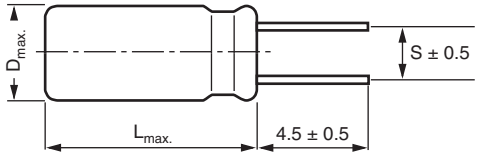


Ø D	5	6.3	8	10	12.5	16	18	22	25
S	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	12.5
Ø d	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0
β	1.5			2.0					
α	0.5							1.0	

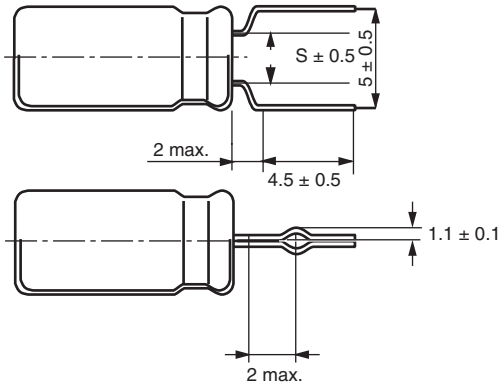
DIMENSIONS in millimeters AND AVAILABLE FORMS



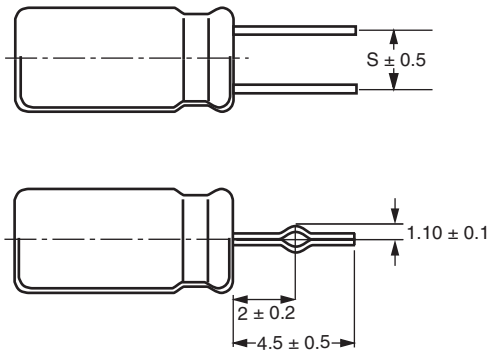
Ø D ≤ 18 long leads MALREKS20...



Ø D ≤ 18 shortened leads MALREKS25...
(S = 2/2.5/3.5/5/7.5 mm)



Ø D ≤ 8 leads shortened and formed MALREKS29...
(S = 2.0/2.5/3.5 mm)



10 ≤ Ø D ≤ 18 leads shortened and formed MALREKS26...
(S = 5/7.5 mm)

GENERAL NOTE

- For Standard Packaging Quantity (SPQ) and Minimum Order Quantity (MOQ) please refer to our price list or contact customer service
- For other packaging forms please refer to Vishay Roederstein General Information

ELECTRICAL DATA

SYMBOL	DESCRIPTION
U_R	rated voltage
C_R	rated capacitance at 120 Hz
tan δ	max. dissipation factor at 120 Hz
R_{ESR}	max. equivalent series resistance at 120 Hz
I_R	rated alternating current (rms) at 120 Hz and upper category temperature

Note

Unless otherwise specified, all electrical values at $T_a = 20$ °C, P = 80 to 120 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

EKSU 470 µF/25 V, ± 20 %, size: 16 x 25 mm
Leads: Long
Ordering code: MALREKS20JG347E00K

Leads: Short
Ordering code: MALREKS25...

For 5 ≤ Ø D ≤ 8 mm
Leads: Bent open, shortened and formed
Ordering code: MALREKS29...

For 10 ≤ Ø D ≤ 18 mm
Leads: Shortened and formed
Ordering code: MALREKS26 ...

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
6.3	33	5 x 11	0.24	9.65	46	0.45	MALREKS20AA233B00K
	68	6.3 x 11	0.24	4.68	76	0.46	MALREKS20BA268B00K
	100	8 x 11.5	0.24	3.18	109	1.10	MALREKS20PB310B00K
	150	10 x 12.5	0.24	2.12	155	1.90	MALREKS20DC315B00K
	220	10 x 12.5	0.24	1.45	188	1.90	MALREKS20DC322B00K
	330	10 x 16	0.24	0.965	252	2.20	MALREKS20DD333B00K
	470	10 x 20	0.24	0.677	328	3.10	MALREKS20DE347B00K
	680	12.5 x 20	0.24	0.468	464	4.00	MALREKS20FE368B00K
	1000	12.5 x 25	0.24	0.318	613	4.40	MALREKS20FG410B00K
	1500	16 x 25	0.26	0.230	800	6.80	MALREKS20JG415B00K
	2200	16 x 35.5	0.28	0.169	1072	11.0	MALREKS20JL422B00K
	3300	18 x 35.5	0.30	0.121	1361	12.3	MALREKS20KL433B00K
	4700	18 x 40	0.32	0.090	1650	12.6	MALREKS20KK447B00K
10	22	5 x 11	0.20	12.1	41	0.45	MALREKS20AA222C00K
	33	6.3 x 11	0.20	8.04	58	0.46	MALREKS20BA233C00K
	47	6.3 x 11	0.20	5.64	69	0.46	MALREKS20BA247C00K
	68	8 x 11.5	0.20	3.90	98	1.10	MALREKS20PB268C00K
	100	10 x 12.5	0.20	2.65	139	1.90	MALREKS20DC310C00K
	150	10 x 16	0.20	1.77	186	2.20	MALREKS20DD315C00K
	220	10 x 20	0.20	1.21	246	3.10	MALREKS20DE322C00K
	470	12.5 x 20	0.20	0.564	422	4.00	MALREKS20FE347C00K
	680	12.5 x 25	0.20	0.390	554	4.40	MALREKS20FG368C00K
	1000	16 x 25	0.20	0.265	745	6.80	MALREKS20JG410C00K
	1500	16 x 35.5	0.22	0.195	999	11.0	MALREKS20JL415C00K
	2200	18 x 35.5	0.24	0.145	1242	12.3	MALREKS20KL422C00K
	3300	18 x 40	0.26	0.104	1534	12.6	MALREKS20KK433C00K
16	15	5 x 11	0.16	14.1	38	0.45	MALREKS20AA215D00K
	22	6.3 x 11	0.16	9.65	53	0.46	MALREKS20BA222D00K
	47	8 x 11.5	0.16	4.52	92	1.10	MALREKS20PB247D00K
	68	10 x 12.5	0.16	3.12	128	1.90	MALREKS20DC268D00K
	100	10 x 16	0.16	2.12	170	2.20	MALREKS20DD310D00K
	150	10 x 20	0.16	1.41	227	3.10	MALREKS20DE315D00K
	330	12.5 x 20	0.16	0.643	396	4.00	MALREKS20FE333D00K
	470	12.5 x 25	0.16	0.452	515	4.40	MALREKS20FG347D00K
	680	16 x 25	0.16	0.312	687	6.80	MALREKS20JG368D00K
	1000	16 x 35.5	0.16	0.212	956	11.0	MALREKS20JL410D00K
	1500	18 x 35.5	0.18	0.159	1184	12.3	MALREKS20KL415D00K
	2200	18 x 40	0.20	0.121	1428	12.6	MALREKS20KK422D00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
25	15	6.3 x 11	0.16	14.1	44	0.46	MALREKS20BA215E00K
	33	8 x 11.5	0.16	6.43	77	1.10	MALREKS20PB233E00K
	68	10 x 16	0.16	3.12	140	2.20	MALREKS20DD268E00K
	220	12.5 x 20	0.16	0.965	323	4.00	MALREKS20FE322E00K
	330	12.5 x 25	0.16	0.643	431	4.40	MALREKS20FG333E00K
	470	16 x 25	0.16	0.452	571	6.80	MALREKS20JG347E00K
	680	16 x 35.5	0.16	0.312	788	11.0	MALREKS20JL368E00K
	1000	18 x 35.5	0.16	0.212	1026	12.3	MALREKS20KL410E00K
	1500	18 x 40	0.18	0.159	1243	12.6	MALREKS20KK415E00K
35	6.8	5 x 11	0.14	27.3	27	0.45	MALREKS20AA168F00K
	22	8 x 11.5	0.14	8.44	67	1.10	MALREKS20PB222F00K
	33	10 x 12.5	0.14	5.63	95	1.90	MALREKS20DC233F00K
	47	10 x 16	0.14	3.95	125	2.20	MALREKS20DD247F00K
	100	10 x 20	0.14	1.86	198	3.10	MALREKS20DE310F00K
	150	12.5 x 20	0.14	1.24	285	4.00	MALREKS20FE315F00K
	220	12.5 x 25	0.14	0.844	376	4.40	MALREKS20FG322F00K
	330	16 x 25	0.14	0.563	511	6.80	MALREKS20JG333F00K
	470	16 x 35.5	0.14	0.395	701	11.0	MALREKS20JL347F00K
	680	18 x 35.5	0.14	0.273	904	12.3	MALREKS20KL368F00K
	1000	18 x 40	0.14	0.186	1151	12.6	MALREKS20KK410F00K
50	10	6.3 x 11	0.12	15.9	41	0.46	MALREKS20BA210H00K
	15	8 x 11.5	0.12	10.6	60	1.10	MALREKS20PB215H00K
	68	10 x 20	0.12	2.34	177	3.10	MALREKS20DE268H00K
	100	12.5 x 20	0.12	1.59	251	4.00	MALREKS20FE310H00K
	150	12.5 x 25	0.12	1.06	336	4.40	MALREKS20FG315H00K
	220	16 x 25	0.12	0.723	451	6.80	MALREKS20JG322H00K
	330	16 x 35.5	0.12	0.482	634	11.0	MALREKS20JL333H00K
	470	18 x 35.5	0.12	0.339	812	12.3	MALREKS20KL347H00K
	680	18 x 40	0.12	0.234	1025	12.6	MALREKS20KK368H00K
63	0.10	5 x 11	0.12	1592	3.9	0.45	MALREKS20AA010J00K
	0.15	5 x 11	0.12	1061	4.8	0.45	MALREKS20AA015J00K
	0.22	5 x 11	0.12	723.5	5.8	0.45	MALREKS20AA022J00K
	0.33	5 x 11	0.12	482.3	7.2	0.45	MALREKS20AA033J00K
	0.47	5 x 11	0.12	338.6	8.5	0.45	MALREKS20AA047J00K
	0.68	5 x 11	0.12	234.1	10	0.45	MALREKS20AA068J00K
	1.0	5 x 11	0.12	159.2	12	0.45	MALREKS20AA110J00K
	1.5	5 x 11	0.12	106.1	15	0.45	MALREKS20AA115J00K
	2.2	5 x 11	0.12	72.3	18	0.45	MALREKS20AA122J00K
	3.3	5 x 11	0.12	48.2	23	0.45	MALREKS20AA133J00K
	4.7	6.3 x 11	0.12	33.9	31	0.46	MALREKS20BA147J00K
	6.8	6.3 x 11	0.12	23.4	37	0.46	MALREKS20BA168J00K
	10	8 x 11.5	0.12	15.9	53	1.10	MALREKS20PB210J00K
	15	10 x 12.5	0.12	10.6	76	1.90	MALREKS20DC215J00K
	22	10 x 16	0.12	7.23	101	2.20	MALREKS20DD222J00K
	33	10 x 16	0.12	4.82	124	2.20	MALREKS20DD233J00K
	47	10 x 20	0.12	3.39	161	3.10	MALREKS20DE247J00K
	68	12.5 x 20	0.12	2.34	227	4.00	MALREKS20FE268J00K
	100	12.5 x 25	0.12	1.59	300	4.40	MALREKS20FG310J00K
	150	16 x 25	0.12	1.06	408	6.80	MALREKS20JG315J00K
	220	16 x 35.5	0.12	0.723	567	11.0	MALREKS20JL322J00K
	330	18 x 35.5	0.12	0.482	745	12.3	MALREKS20KL333J00K
	470	18 x 40	0.12	0.339	933	12.6	MALREKS20KK347J00K

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	DIMENSIONS Ø D x L (mm)	tan δ 120 Hz	R_{ESR} 120 Hz (Ω)	I_R 120 Hz/105 °C (mA)	WEIGHT (g)	CATALOG NUMBER (Long Leads)
100	0.10	5 x 11	0.12	1592	4.2	0.45	MALREKS20AA010L00K
	0.15	5 x 11	0.12	1061	5.1	0.45	MALREKS20AA015L00K
	0.22	5 x 11	0.12	723.5	6.2	0.45	MALREKS20AA022L00K
	0.33	5 x 11	0.12	482.3	7.5	0.45	MALREKS20AA033L00K
	0.47	5 x 11	0.12	338.6	9.2	0.45	MALREKS20AA047L00K
	0.68	5 x 11	0.12	234.1	11	0.45	MALREKS20AA068L00K
	1.0	5 x 11	0.12	159.2	13	0.45	MALREKS20AA110L00K
	1.5	5 x 11	0.12	106.1	16	0.45	MALREKS20AA115L00K
	3.3	6.3 x 11	0.12	48.2	27	0.46	MALREKS20BA133L00K
	6.8	10 x 12.5	0.12	23.4	54	1.90	MALREKS20DC168L00K
	10	10 x 12.5	0.12	15.9	65	1.90	MALREKS20DC210L00K
	15	10 x 16	0.12	10.6	88	2.20	MALREKS20DD215L00K

LOW TEMPERATURE BEHAVIOUR (at 120 Hz)

IMPEDANCE RATIO Z (T2)/Z (T1)	RATED VOLTAGE (V)			
T2/T1	6.3	10	16	25 ~ 100
- 25 °C/+ 20 °C	4	3	2	2
- 40 °C/+ 20 °C	8	6	4	3

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Current		
Leakage current (Test conditions: U_R, 20 °C)	After 5 minutes at U_R	$I_{L5} \leq 0.03 \times C_R \times U_R$ or 3 µA (whichever is greater)
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$	ESR = tan $\delta / 2 \pi f C_R$

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY

FREQUENCY (Hz)	I_R MULTIPLIER FOR $U_R \leq 100$ V		
	$C_R \leq 47$ µF	C_R = 68 to 680 µF	$C_R \geq 1000$ µF
50	0.75	0.80	0.85
120	1.00	1.00	1.00
300	1.35	1.25	1.10
1000	1.55	1.34	1.13
≥ 10 000	2.00	1.50	1.15

TEST PROCEDURES AND REQUIREMENTS

TEST	PROCEDURE (quick reference)	REQUIREMENTS
Load life	T_{amb} = 105 °C U_R and I_R applied After 1000 hours Polarity reverse each 250 hours	Δ C/C: ± 20 % of initial value $I_L \leq$ spec. limit tan $\delta \leq 2$ x spec. limit
Shelf life	No voltage applied After 1000 hours After test: U_R to be applied for 30 minutes 24 to 48 hours before measurement	Δ C/C: ± 20 % of initial value $I_L \leq$ spec.limit tan $\delta \leq 2$ x spec. limit

Vishay
OS-CON

Contents

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

INTRODUCTION

Vishay OS-CON capacitors are electrolytic capacitors. Up to now, an electrolytic solution and manganese dioxide have been used as the electrolyte in electrolytic capacitors. In development of a new highly efficient electrolytic capacitor which has a high conductivity (organic semi-conductor) when compared to earlier electrolytes, we have successfully worked out the Vishay OS-CON electrolytic capacitors with low impedance, using an organic semiconductor for the electrolyte.

FEATURES

- Vishay OS-CON capacitors are low ESR capacitors. Impedance frequency characteristics are plotted in a highly desirable curve. (Best suited to use as de-coupling capacitors for removing such noise as ripple, spike, digital, static and audio.)
  Able to flow large ripple current. (Best suited for miniaturization, used as smoothing capacitor of switching power supply.)
  Able to discharge rapidly. (Best suited for use as back-up capacitor in a circuit where large current is consumed at high-speed.)
- Equivalent Series Resistance (ESR) is not dependent on temperature. (Best suited for devices that have low temperature specifications of 0° Centigrade or less.).
- Vishay OS-CON capacitors have long life. You can expect to use the capacitors for 50 000 hours at + 85 °C (Type 94SH). (Best suited for industrial devices that shall be used for a long period.)
- Vishay OS-CON capacitors have polarity but that is strong against reverse voltage. (Best suited for a circuit that needs capacitance and where electric potentia slightly oscillates with reverse voltage.)
- Vishay OS-CON capacitors costs "Price x ESR (Ω)". They are inexpensive. (Pricewise advantageous for capacitors of 10 µF or more.)

APPLICATION NOTES

The Vishay OS-CON capacitor is a uniquely structured solid aluminum electrolytic capacitor. Please note the following points in order to take full advantage of the capacitors performance and ensure the most stable quality possible.

Polarity:
Vishay OS-CON capacitors are solid aluminum electrolytic capacitors with positive and negative electrodes. Do not reverse the polarity when using. If it is used with the polarities reversed, increased leakage current or a decreased life span may result.

Prohibited Circuits:
Since problems can be expected due to the leakage current fluctuations that occur during soldering and other processes, the capacitors cannot be used on the following circuits.

1. High impedance voltage retention circuits.
2. Coupling circuits.
3. In addition to the leakage current fluctuation above, the operational conditions such as characteristics of temperature, anti-humidity and high temperature loads stipulated in the delivery specifications will affect the electrostatic capacity. This electrostatic capacity fluctuation may cause problems if it is used as a time constant capacitor, which is extremely sensitive to the fluctuation of electrostatic capacity. Do not use it as a time constant capacitor.
4. Circuits greatly affected by leakage current.
5. The circuit in which two or more capacitors are connected in series so as to raise the endurance voltage of them.

Overvoltage Prohibited During Design:
Overvoltage exceeding the rated voltage may not be applied even for an instant as it may cause a short circuit.

Sudden Charge and Discharge Restricted:
Sudden charge and discharge restricted (for maintenance of high-proof reliability). A protection circuit is recommended when a sudden charge or discharge causes excessive rush current because this is a main cause of short circuits and large leakage current. Use protection circuits when the rush current value is ten times larger than the allowable ripple current value and for circuits whose rush current value exceeds 10 A. (Refer to pages 43 to 45.) Be sure to insert a protection resistor of about 1 kΩ for charge and discharge when measuring the leakage current.

Considerations When Soldering:
The soldering conditions are to be within the range prescribed in the delivery specification. If the specifications are not followed, there is the possibility of the appearance becoming defective and of increase of abnormal leakage current and capacity reduction when soldering is conducted under conditions that are harsher than those stipulated.

Sufficient PC Board Installation Space:
The design must give consideration to the standard of lead position displacement given in the delivery specification. The capacitors may not be able to be inserted in the PC board if there is insufficient space.

Considerations When Using in Industrial Equipment:
To insure reliability when the capacitor is used in industrial equipment, design must allow for its capacitance, impedance and other characteristics.

Using in Equipment Regarding Human Life:
If using in equipment regarding human life (e.g. space, aeronautic and atomic equipment, etc.), contact the factory for more information. Do not use without recognition document of Vishay OS-CON.

Circuit Designing Cautions:

1. Rated Performance

Check the rated performance. After checking the operation and installation environments, design the circuit so that it falls within the rated performance range stipulated in the catalog or delivery specification. The peak current value of the diode when absorbing counter electromotive force.

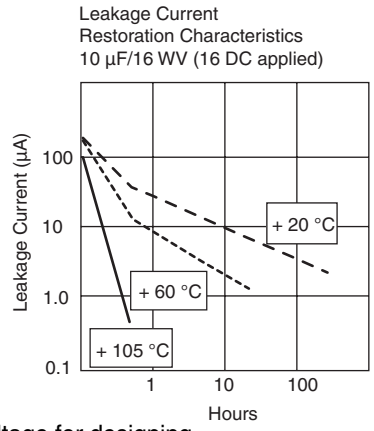
2. Operating temperature and ripple current.

a. Set the operating temperature so that it falls within the range stipulated in the catalog or delivery specification.

b. Do not supply current that exceeds the allowable ripple current. When excessive ripple current is supplied, internal heat increases and reduces the capacitor's life span.

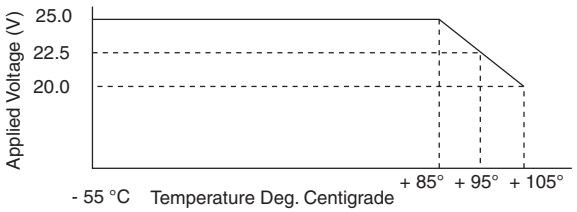
3. Leakage Current.

Even when the soldering conditions fall within the range of the delivery specification, leakage current increases a little on occasion. It also increases a little during high temperature no-load, moisture-proof no-load and temperature cycling tests with no voltage applied. In cases such as these, leakage current will decrease by applying voltage that falls below the capacitor's maximum operating temperature. The speed at which the leakage current is restored is increased by applying a high voltage under voltage rating when the capacitor's temperature is close to the maximum operating temperature. Refer to the following diagram.



4. Applied voltage for designing.

a. Less than 80 % of the rated voltage is recommended to be applied to more than 10 WV products. Less than 90 % is recommended for 6.3 WV products. For 4 WV products, 100 % of the rated voltage can be applied without causing any problems. Use less than 80 % of the following temperature reduction voltage for 25 WV products. This does not need to be applied to products between 4 and 20, 30 WV products. Refer to the following diagram.



b. Make sure the sum of the peak DC voltage and ripple voltage values does not exceed the rated voltage.

c. When the DC voltage is low, set it so that the negative ripple voltage peak value does not become a a reverse voltage that exceeds 10 % of the rated voltage

d. Use the capacitor within 20 % of the rated voltage for application of reverse voltage during the transient phenomena caused when the power is turned off or the source is switched. Use it within 10 % of the rated voltage when reverse voltage is applied continuously.

5. Reduction of failure stress.

The main failure mode of the capacitor is open mode primarily caused by electrostatic capacity drop at high temperature (i.e. wear out failure), besides random short circuit mode failures primarily caused by over voltage occurs as minor one. The time it takes to reach the failure mode can be extended by using the capacitor with reduced ambient temperature, ripple current and applied voltage. The failure rate is less than 0.5 %/1000 hours when used at 60 % of the confidence level with the prescribed voltage applied at + 105 °C.

6. Capacitor insulation.

a. Insulation in the marking sleeve is not guaranteed. Be aware that the space between the case and the negative electrodes terminal is not insulated and has inconstant resistance.

b. Be sure to completely separate the case, negative electrode terminal, positive electrode terminal from adjacent and components and PC board foil.

7. Operating environment restrictions.

Do not use the capacitor in the following environments:

a. Places where water, salt water or oil can directly fall on it and places where condensation may form.

b. Places filled with noxious gas (hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, ammonia, etc.).

c. Places susceptile to ozone, ultraviolet rays and radiation.

8. Lead Pitch.

The pitch and diameter of PCB holes to which the Vishay OSCON capacitor is mounted should be designed to conform to the dimensional tolerance stipulated in the delivery specifications.

9. PC Board Design.

a. Avoid locating heat-generating components around the Vishay OS-CON capacitor and on the under side of the PC board underneath the capacitor.

b. Follow the recommendations given in the catalog or delivery specification for land patterns for chip-type (94SM, 94SN and 94SV Series) PC boards when designing circuits.

10. Parallel connection.

A large amount of ripple current may be applied to the capacitor when it is used in parallel connection with another capacitor. Carefully select the type of capacitor. (Refer to page 45 for details.)

11. Design circuits after checking the following items:

a. Electrical characteristics are affected by temperature and frequency fluctuations. Design circuits after checking the amount of fluctuation.

b. When mounting a Vishay OS-CON on a double-sided PC board, design it so that extra PC board holes and the through holes for connecting the front and back of the PC board are not located underneath the capacitor.

Mounting Precautions:

1. Things to know before mounting:

a. Do not reuse Vishay OS-CON capacitors that have been assembled in a set and energized. Excluding capacitors that have been removed for measuring electrical characteristics during a periodic inspection, they cannot be reused.

b. Leakage current may have increased in capacitors that have been stored for a long period of time. In this case, use after treatment of rated voltage with an approximately 1 kilohm resistor at about + 60 °C to + 70 °C for 1 hour.

2. Mounting (1).

a. Mount after checking the capacitance and the rated voltage.

b. Mount after checking the polarity.

c. Do not drop the capacitor on the floor. Do not use capacitors that have been dropped.

d. Do not deform and then mount a Vishay OS-CON capacitor.

3. Mounting (2).

a. Mount after checking that the capacitor's lead pitch and the PC board holes pitch match.

b. When an automatic inserter is used to clinch the capacitor's lead wires, make sure it is not set too strong.

c. Be careful of the shock force that can be produced by absorbers, product checkers and centerers on automatic inserters and installers.

d. Do not apply excessive external force to the lead wires, the capacitor itself, and electrode terminals.

4. Soldering with a soldering iron.

a. Set the soldering conditions (temperature, time) so that they fall within the range stipulated in the delivery specification.

b. When the lead wire terminal must be processed because the terminal spacing and the PC board holes spacing do not match, process it before soldering so that no stress is applied to the capacitor itself.

c. Do not subject the capacitor itself to excessive stress when soldering with a soldering iron.

d. When a soldering iron is used to repair a capacitor that has already been soldered once and needs to be removed, remove it after the solder has been completely melted so that no stress is applied to the capacitor's terminal.

e. Do not let the tip of the soldering iron touch the capacitor itself.

f. The LC value after soldering may increase a little (from a few µA to several hundred µA) depending on the soldering conditions (preheating and solder temperature and time, PC boards material and thickness, etc.). The leakage current can be reduced through self-repair by applying voltage.

5. Flow soldering.

a. Do not solder the capacitor by submerging it in melted solder. Use the PC board to protect the capacitor and only solder the opposite side that the capacitor is mounted on.

b. Set the soldering conditions (soldering temperature, terminal submersion time) so that they fall within the range stipulated in the delivery specification. Types 94SC, 94SA, 94SH, 94SS (larger than size D), 94SP (sizes E, F, G) at + 260° for less than 10 seconds, 94SL, 94SS (smaller than size C'), 94SP (sizes C', E', F') at + 260 °C for less than 5 seconds.
The LC value after soldering may increase a little (from a few µA to several hundred µA) depending on the soldering conditions (preheating and solder temperature and time, PC boards material and thickness, etc.). The leakage current can be reduced through self-repair by applying voltage.

c. Take care that flux does not adhere to any place other than the terminal.

d. When soldering, take care that other components do not fall over and touch the capacitor.

e. Flow soldering under extremely abnormal conditions may reduce the electrostatic capacity of the products before or after soldering.

6. Reflow soldering.

a. Do not use reflow soldering for lead-type Vishay OS-CON capacitors.

b. Set the soldering conditions (preheating, soldering temperature and time) so that they fall within the range stipulated in the catalog or delivery specification. SMD product (Type 94SVP) preheat for less than 120 seconds at:
+ 150 °C the peak of case or terminal must be less than + 230 °C; retention time at temperatures exceeding + 220 °C shall be less than 15 seconds; retention time at temperatures exceeding + 200 °C shall be less than 20 seconds; and reflow time shall be less than 30 seconds. The LC value after soldering may increase a little (from a few µA to several hundred µA) depending on the soldering conditions (type of reflow furnace, reflow conditions, PC boards material and thickness, number of components, etc.). The leakage current can be reduced through selfrepair by applying voltage.

c. Reflow may only be conducted once. If reflow must be conducted twice, please contact Vishay OS-CON.

d. Set the VPS soldering conditions so that they fall within the range stipulated in the delivery specification.

e. Reflow soldering may reduce the electrostatic capacity of products before or after soldering even if soldering conditions stipulated in catalog and delivery specifications are met.

7. Handling after soldering.

a. Do not tilt, bend or twist the capacitor after it has been soldered on the PC board.

b. Do not use the capacitor like a handle to move the PC board after it has been soldered to it.

c. Do not bump the capacitor with objects after it has been soldered to the PC board. When stacking PC boards, make sure that the capacitor does not touch other PC boards or components.

d. Do not subject the capacitor to excessive stress after it has been soldered to the PC board.

8. Washing the PC board

Check the following items before washing the PC board with these detergents; High quality alcohol based cleaning fluid such as Pine-αST-100S, Clean thru 750H, 750L, 710M, 750K, or Techno Care FRW14 through 17; or detergents including substitute freon such as AK-225AES and IPA.

a. Use immersion or ultrasonic waves to clean for a total less than five minutes. (Less than two minutes for the 94 SV.)

b. The temperature of the cleaning fluid should be less than + 60 °C.

d. After cleaning, do not store the capacitor in a location subject to gases from the cleaning fluid or in an airtight container. Dry the PC board and capacitor with hot air (less than the maximum operating temperature). Note that when it is heated (heat run, dry, etc.) soon after cleaning, the sleeve may swell and shrink again.

9. Fixatives and coatings.

a. Select appropriate materials for the capacitor's material and sealant. In particular, make sure coating and thinner do not contain acetone.

b. Before applying the fixative or coating, completely remove any flux residue and foreign matter from the area where the PC board and the capacitor are to be joined together.

c. Allow any detergent to dry before applying the fixative or coating.

Precautions with Completed Board:

1. Do not directly touch the capacitor's terminals

2. Do not use electric conductors to cause short circuits between the capacitor's terminals. Do not subject the capacitor to conductive solutions such as acids and alkaline water solutions.

3. Check the installation environment of the board the capacitor is installed in.

4. Age the board at conditions that fall below the capacitors ratings.

5. It is recommended that the board be used at room temperature and in ordinary humidity.

In the Event that Something Unfortunate Should Occur:

1. In the event that a short circuit causes the current to become relatively small (less than approximately 3 A for Ø 10 and less than approximately 1 A for Ø 6.3), the capacitor itself will generate a little heat, but the appearance will not be affected even when electricity is supplied continuously.
However, if the short circuits current value exceeds the above mentioned values, the temperature inside the capacitor will increase. When the temperature exceeds approximately + 220 °C, the impregnated organic semiconductor melts and liquefies, the internal pressure is raised, and the liquefied organic semiconductor and odorous gas is released from the space between the sealant and the aluminum case and lead wires. In this case, keep your face and hands away from the area.

2. If a short circuit occurs and odorous gas is released, either turn off the sets main power or unplug the power cord from the outlet.

3. If a short circuit should occur, it may take anywhere from a few seconds to a few minutes until the organic semiconductor liquefies and an odorous gas develops, depending on the conditions. Set it up so that a power protection circuit works during this time .

4. If the gas gets in your eyes, rinse them immediately. Gargle if it has been inhaled.

5. Do not lick the capacitor's electrolyte. When the electrolyte gets on your skin, wash it off with soap.

6. The electrolyte, separator, resin and tube used in the Vishay OS-CON capacitor are all combustible. When the current value is extraordinarily large after a short circuit, assuming the worst possibility, the shorted-out section in the lead wire or inside the capacitor has created a spark, and it may have caught fire to the resin and/or tube. Give consideration to the capacitors mounting method, mounting position, pattern design and such.

Storage Conditions:

1. Do not store the capacitor at high temperatures and high humidity. Store it in a location that is not subject to direct sunlight and that has low temperatures and humidity (generally, temperatures between + 15 °C and + 35 °C and a relative humidity of less than 75 %).

2. Store the capacitor in an airtight plastic bag to keep the leads in good condition. There are special bags for Types 94SM, 94SN and 94SV.

3. To keep the leads in good condition, store lead-type capacitors for no more than one year, and SMD types for no more than six months.

4. For SMD types in particular, open the bag just before mounting and use up all the capacitors in the bag as far as is possible. If some are unavoidably left over, return them to the bag and seal the opening with tape.

5. Do not store the capacitors in places where water, salt water or oil can directly fall on it, or places where condensation may form.

6. Do not store the capacitors in places filled with noxious gas (hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, ammonia, etc.).

7. Do not store the capacitor in places susceptible to ozone, ultraviolet rays and radiation.

Disposal:

The Vishay OS-CON capacitor is comprised of solid organic compounds, various metals and resin. Treat it as industrial waste when disposing of it.

General Specifications

Vishay OS-CON

Solid Aluminum Capacitors
with Organic Semiconductor Electrolyte

PART NUMBER EXPLANATION

94SA	476	X0	6R3	A	XX	OR	XX
VISHAY OS-CON TYPE	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING	CASE CODE	PROCESS CODE*		PACKAGING
94SA 94SC 94SH 94SL 94SS 94SP 94SVP	This is expressed in picofarads (pF). The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = ± 20 %	This is expressed in volts. To comploete the three digit block,zeros precede the voltage rating if the voltage is under 100. Example: 010 = 10 V. A decimal is expressed as follows: 6R3 = 6.3 V	A, A' B, B' C, C' D E, E' F,F' G H	CA CC CD F0 F1 F2 C0 C1 C2 C3		BP (BULK) A1 (AMMO) A2 (AMMO)

Note When using process codes, bulk packaging is assumed. See below.

MINIMUM PACKAGING QUANTITIES

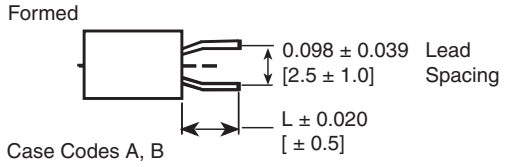
Bulk Packaging		Ammo Packaging		Type 94 SVP Tape and Reel	
Case Code	**Quantity**	**Case Code**	**Quantity**	**Case Code**	**Quantity**
A	500	A	2000	A5	2000
B	500	B	2000	B6	1500
C	500	C	1500	C6	1000
D	500	D	1500	E7	1000
E	200	E	1000	F8	500
F	200	F	500	E12	400
G	50	-	-	F12	400
H	25	-	-	-	-

LEAD SPACING (AMMO) Dimensions in inches [millimeters]

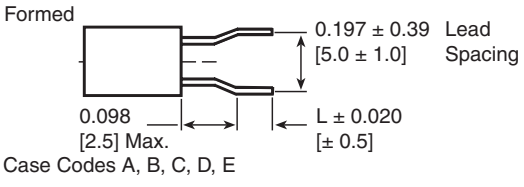
A2	F = 0.098" [2.5 mm]	Available in case sizes A, B, C, D
A1	F = 0.197" [5.0 mm]	Available in case sizes A, B, C, D, E, F
A2	F = 0.138" [3.5 mm]	For "E" case size only

Note "F " = Lead Spacing Dimensions

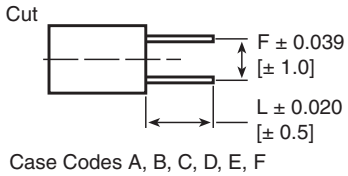
LEAD FORM DIMENSIONS in inches [millimeters]



PROCESS CODE	LEAD LENGTH (L)
+ CA	0.217 [5.5]
+ CC	0.157 [4.0]
+ CD	0.098 [2.5]



PROCESS CODE	LEAD LENGTH (L)
+ F0	0.217 [5.5]
+ F1	0.177 [4.5]
+ F2	0.118 [3.0]

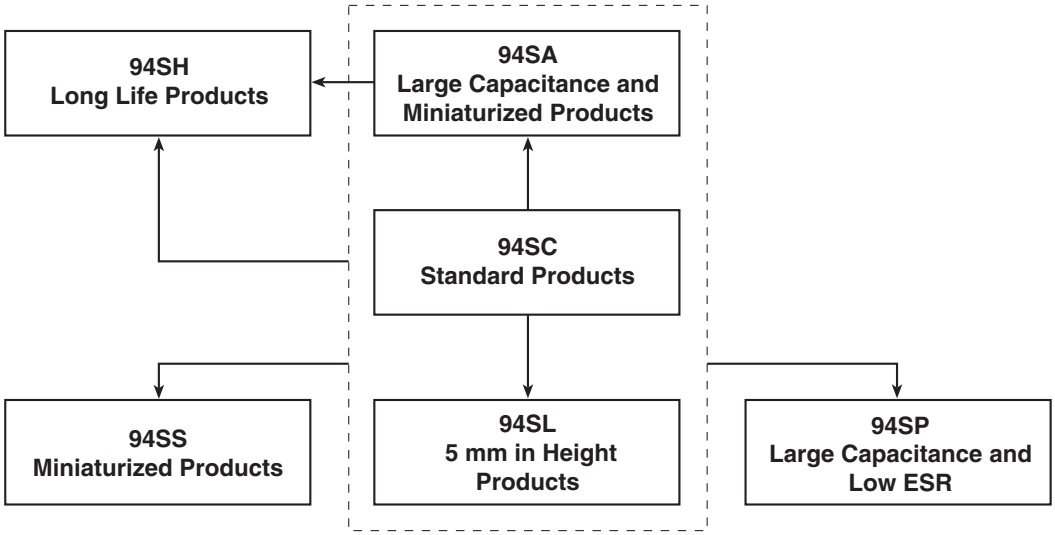


Note Lead Spacing as same as Long Leads

PROCESS CODE	LEAD LENGTH (L)
+ C0	0.217 [5.5]
+ C1	0.157 [4.0]
+ C2	0.098 [2.5]
+ C3	0.138 [3.5]

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

RADIAL TYPE



SURFACE MOUNTING TYPE

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

VISHAY OS-CON CAPACITOR ESR MATRIX TABLE							
ESR (mΩ)	WV						
	4 V	6.3 V	10 V	16 V	20 V	25 V	30 V
10	SP (G, FO)	-	-	-	-	-	-
12	SP (F)	-	-	-	-	-	-
13	-	SP (F)	-	-	-	-	-
14	SP (E)	-	-	-	-	-	-
15	-	SA (H)	SP (F)	SA (H)	-	-	-
16	-	SP (E)	-	-	-	-	-
18	-	-	SP (E)	SP (F)	-	-	-
20	-	-	-	SA (G), SP (E)	SP (F)	-	-
24	SP (F')	-	-	-	SP (E)	-	-
25	SS (F)	SH, SA (F)	SS (F)	-	-	-	-
26	-	SP (F')	-	-	-	-	-
27	-	-	SA, SH (F)	-	-	-	-
28	SP (E')	-	SP (F')	SA, SH (F)	-	-	-
30	-	SA, SH, SS (E) SP (E')	SS (E)	SA, SH (E) SP (F')	SA, SH (F) SS (E, F)	-	-
32	-	-	SP (E')	-	SP (F')	-	-
34	-	-	-	SP (E')	-	-	-
35	SP (C)	SP (C)	-	-	-	SC (F)	-
36	-	-	-	-	SA, SH (E) SP (E')	-	-
40	SP (C'), SS (D)	SP (C')	SP (C), SS (D)	-	SA, SH (E)	SC (E)	-
45	-	-	SP (C')	SP (C)	SP (C)	-	-
50	-	-	SA, SH (D)	SP (C'), SS (D)	SP (C')	-	-
55	SL (F')	-	-	-	-	-	-
60	SL (E')	SA, SH (C) SL (F')	SL (F'), SC (D)	SA, SH (D)	SS (D)	-	-
65	-	SL (E')	SL (E')	SL (F')	-	-	-
70	SS (C')	SC (C)	SL (C'), SC (C)	SA, SH (C), SL (E'), SC (D)	SA (C, D) SH (C, D)	SC, SH (D), SL (F')	-
75	-	-	-	-	-	SL (E')	-
80	-	-	SL (C')	-	-	-	SC (F)
90	-	-	-	SH, SC (C)	SA, SH (C)	SC, SH (C)	-
100	-	-	-	SL (C'), SS (C')	SS (C')	SC, SH (C), SL (C')	-
110	-	-	-	-	-	-	SC (E)
120	-	SC, SH (B), SL (B')	-	-	-	-	SC (D)
150	-	SS (B')	SC, SH (B) SS, SL (B')	SC, SH (B) SS (B')	-	-	-

Notes

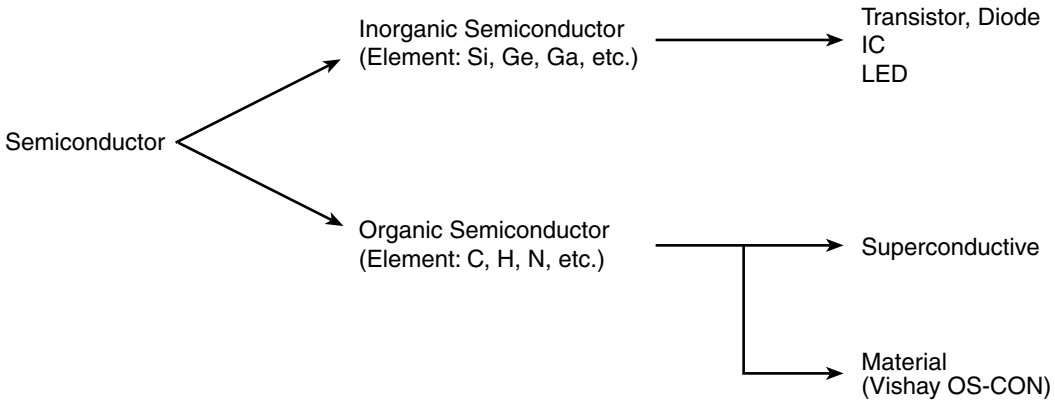
This ESR Matrix table is limited to types which are lead type and have ESR of less than 150 mΩ

ESR: 100 kHz to 300 kHz at 25 °C (mΩ)

( ): Case size

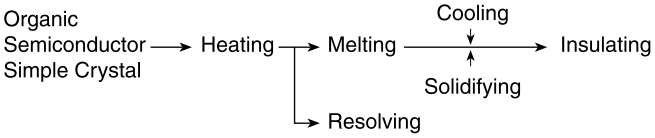
Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

VISHAY OS-CON SEMICONDUCTOR

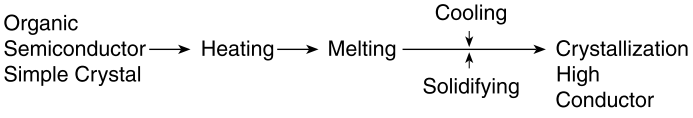


VISHAY OS-CON ORGANIC SEMICONDUCTOR

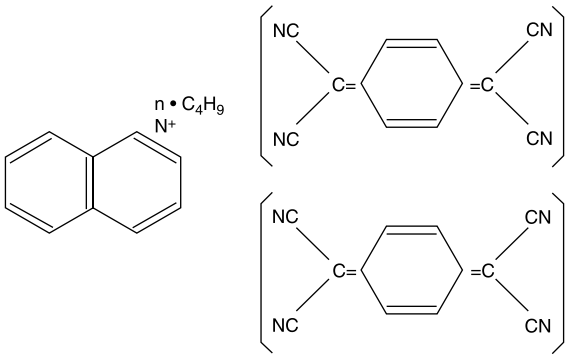
Conventional Organic Semiconductor



Developed Organic Semiconductor



TCNQ Complex Salt



N-n-butyl Isoquinolinium $(TCNQ)_2$

FEATURES OF ORGANIC SEMICONDUCTOR AS ELECTROLYTE

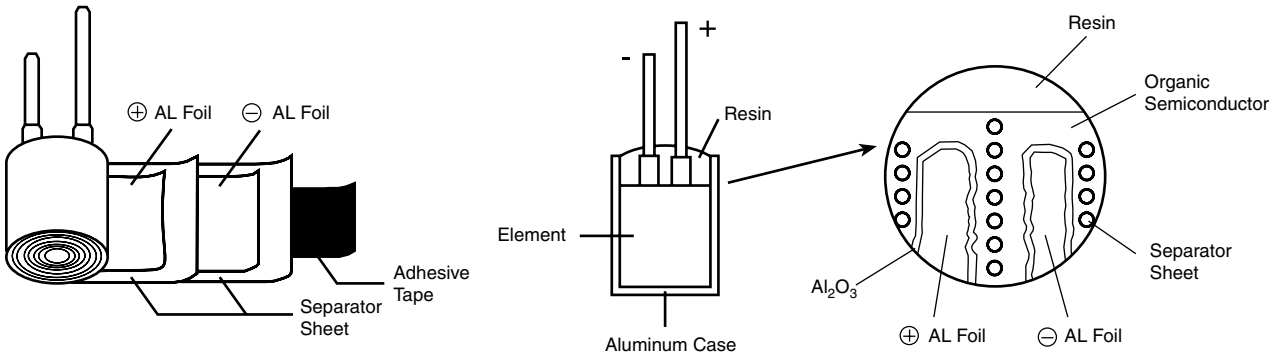
- High conductivity (low resistance value) compared to other electrolytes.
- High conductivity provides stability against temperature.

TYPE OF CAPACITOR	TYPE OF ELECTROLYTE	CONDUCTIVITY (mS/cm) [1]
Non-solid Electrolyte Capacitor	Electrolyte Solution	3
Solid Electrolyte Capacitor	Manganese Dioxide	30
Vishay OS-CON Capacitor	Organic Semiconductor	300

Note

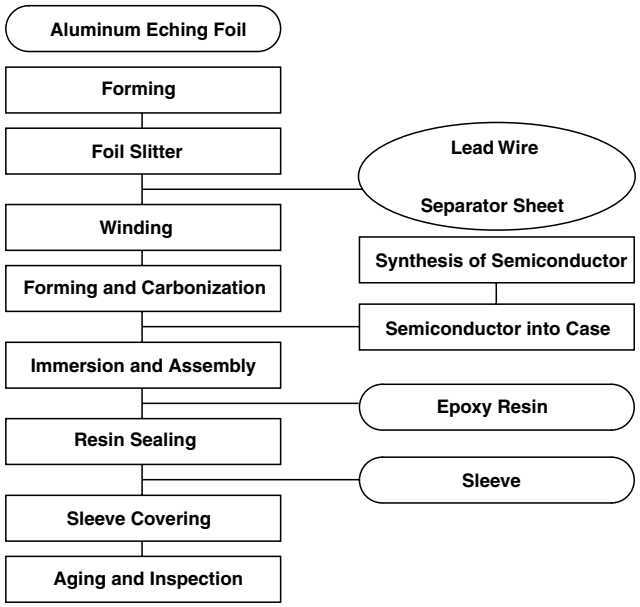
[1] Conductivity comparisons are abbreviated values.

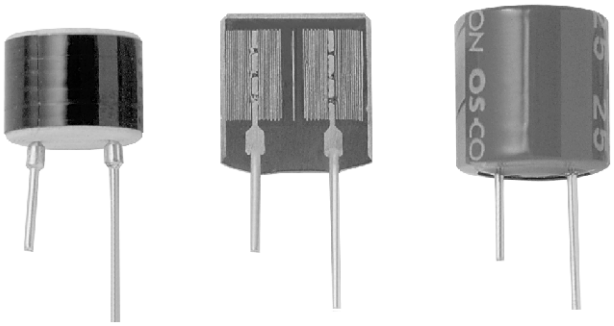
CONSTRUCTION



Vishay OS-CON capacitors are roughly the same construction as an aluminum electrolytic capacitor, and uses a rolled aluminium foil in its capacitor element. Vishay OS-CON differs from the alumnium electrolyte capacitor in that in place of the electrolyte solution, organic semiconductor crystal is impregnated, and the Vishay OS-CON capacitor is encased with an epoxy resin instead of a rubber encasing (Type 94SVP has a rubber encasing, others have resin encasing).

MANUFACTURING PROCESS



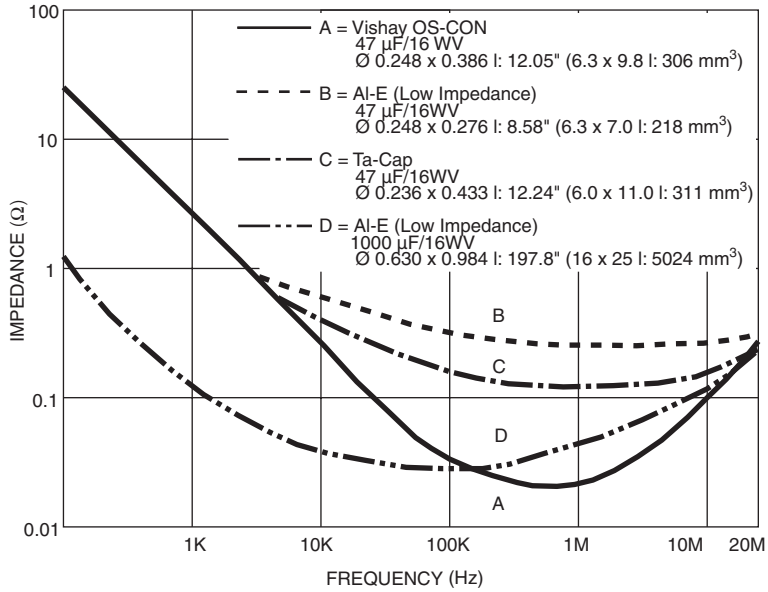


Winding Element | Cross Section | Finished Goods

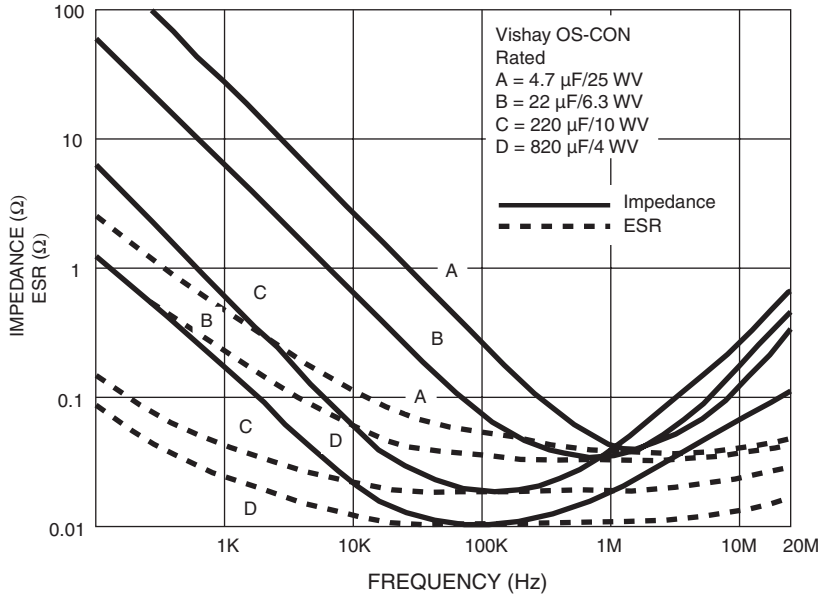
Solid Aluminum Capacitors with Organic Semiconductor

FREQUENCY CHARACTERISTICS (AT 25 °C)

The greatest feature of the Vishay OS-CON capacitor is its excellent frequency characteristic which is nearly equal to that of a film capacitor. Using the high conductivity of an organic semiconductor with an electrolyte, and adopting the winding element for layer thinness of electrolyte, the ESR (Equivalent Series Resistance) is greatly improved, obtaining the frequency characteristic nearly to the film capacitor.

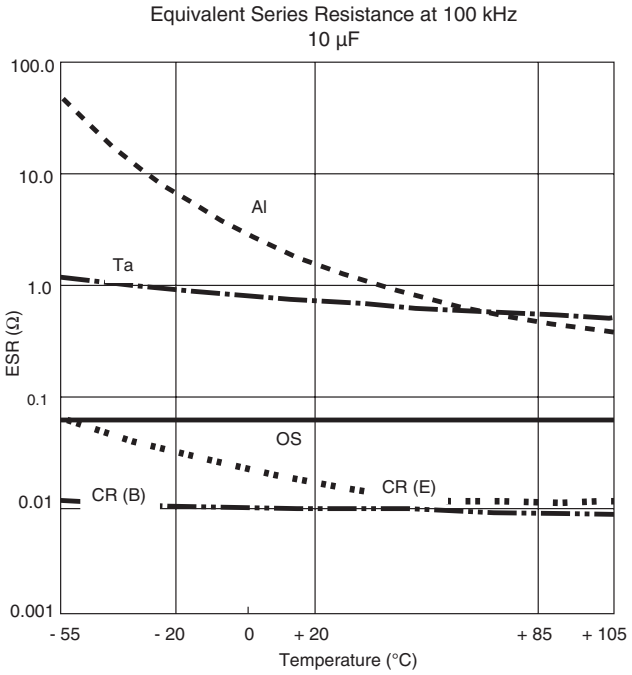


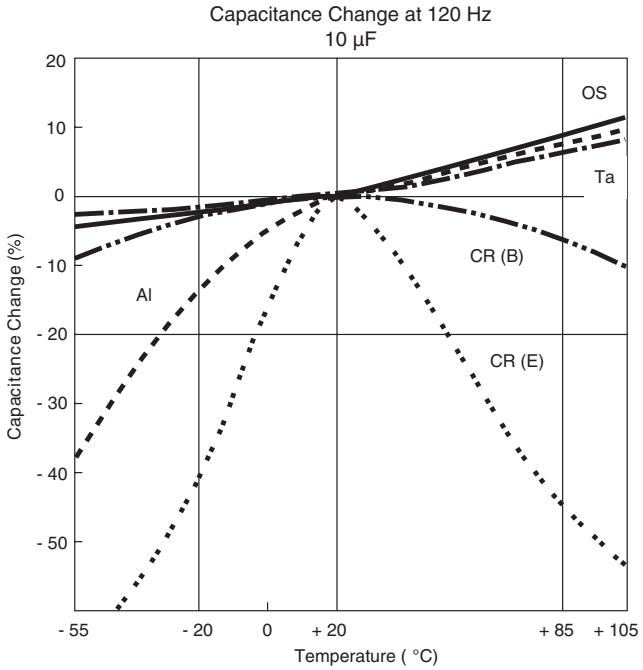
The chart above shows the impedance frequency characteristic of Vishay OS-CON, compared to that of other types of capacitors. The Vishay OS-CON capacitor shows a nearly ideal curve. When compared at 100 kHz of frequency, a Vishay OS-CON capacitor 47 µF and low impedance aluminum electrolytic capacitor 1000 µF nearly have the same feature. If the frequency gets higher, the capacitance ratio between the Vishay OS-CON capacitor and aluminum electrolytic capacitor becomes bigger.



This chart shows the impedance and ESR frequency characteristics for each size of Vishay OS-CON capacitors. The resonance point of the Vishay OS-CON capacitor is at 100 kHz to 10 MHz. The ESR becomes about 10 mΩ or less at 100 kHz (829 µF rating), an extremely small value.

TEMPERATURE CHARACTERISTICS

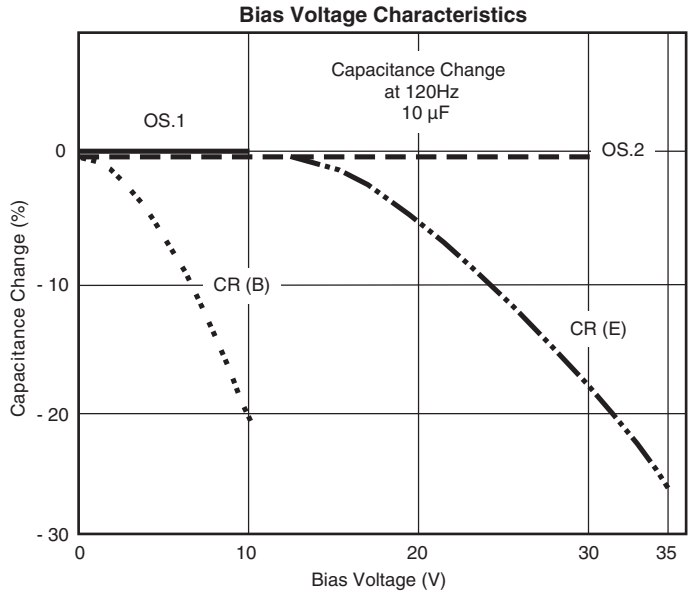




OS = Vishay OS-CON
Al = AL-E Capacitor
Ta = Tantalum Capacitor
CR(B) = Cera Capacitor (B Type)
CR(E) = Cera Capacitor (E Type)

The temperature characteristics of the Vishay OS-CON capacitor features little changes in temperature for the ESR. Since ESR is dominant at the high range of impedance (near resonance point), the ESR value greatly affects noise clearing capacity. When ESR changes little against the temperature it means that the noise clearing ability changes little against temperature as well.
The Vishay OS-CON capacitor is best suited for outdoor apparatus, vehicles and machinery.

BIAS CHARACTERISTICS



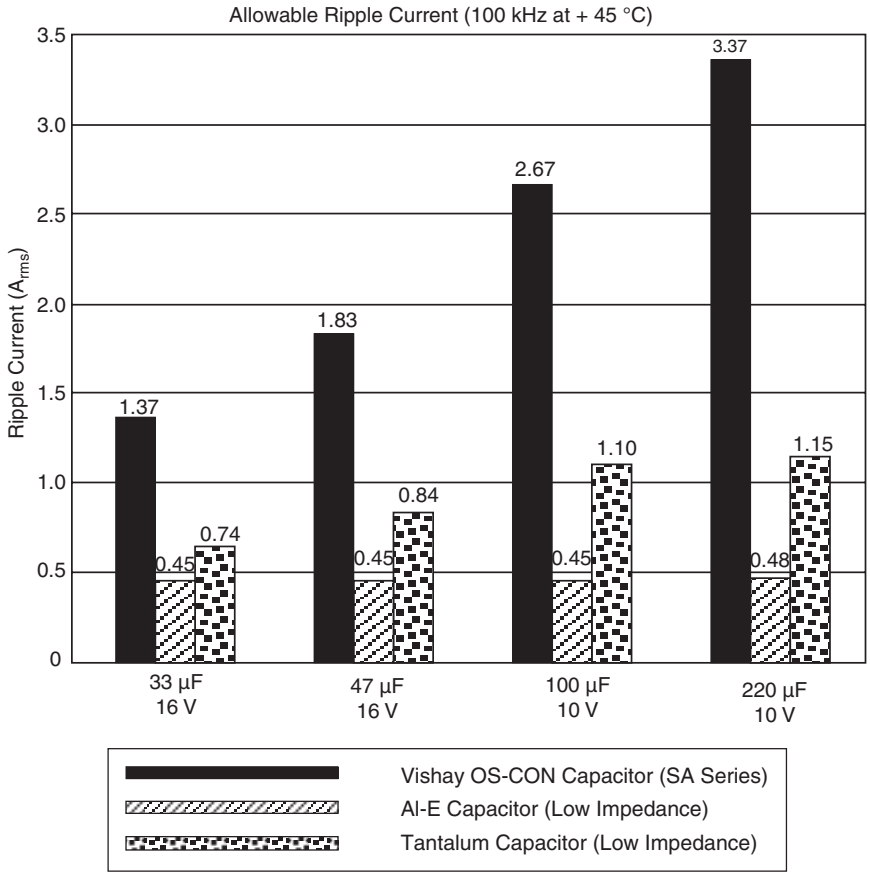
OS.1 = Vishay OS-CON Capacitor (94SL106X0010B)

OS.2 = Vishay OS-CON Capacitor (94SC106X0030E)

CR (B) = Cera Capacitor (B Type, 10 V, 10 µF)

CR (E) = Cera Capacitor (E Type, 50 V, 10 µF)

When voltage within rating is applied to the Vishay OS-CON capacitors (less than 80 % of the rated voltage is recommended) it shows a stable characteristic where the capacitance changes little. Also when regarding bias characteristics, which must be considered in using ceramic capacitors, the Vishay OS-CON capacitors can be used safely.



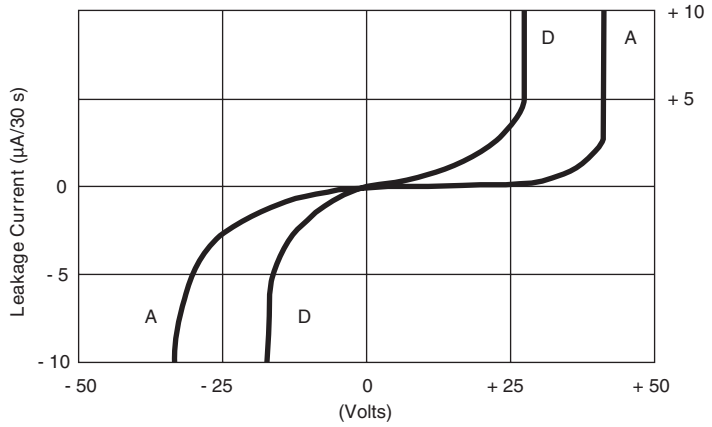
When selecting a smoothing capacitor for a power supply, the allowable ripple current of the capacitor becomes one of the standard selections.

The allowable value of the ripple current is decided by the generated heat of the capacitor, but its heating comes out of ESR. Since a large ESR capacitor generates larger heat value, it can not make the flow of ripple current greater.

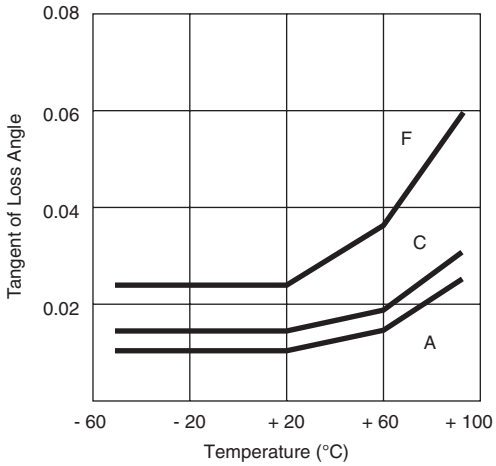
The Vishay OS-CON capacitor has a small ESR, and compared to other electrolytic capacitors, can allow far more ripple currents.

TYPICAL CURVES

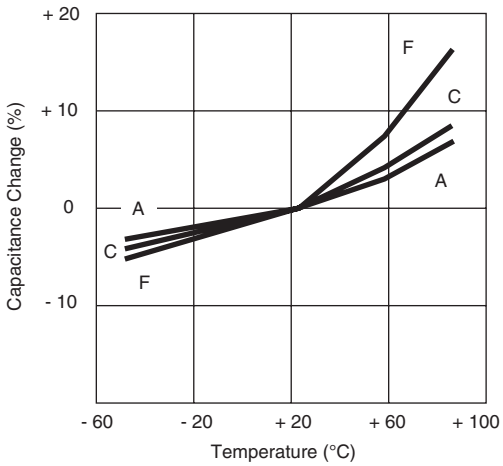
Leakage Current vs. Charged Voltage



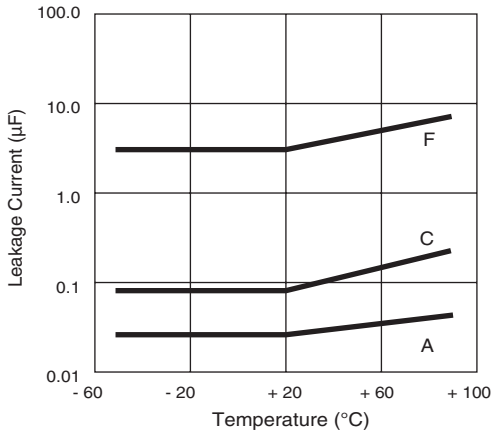
Temperature vs. Tangent of Loss Angle
(120 Hz)



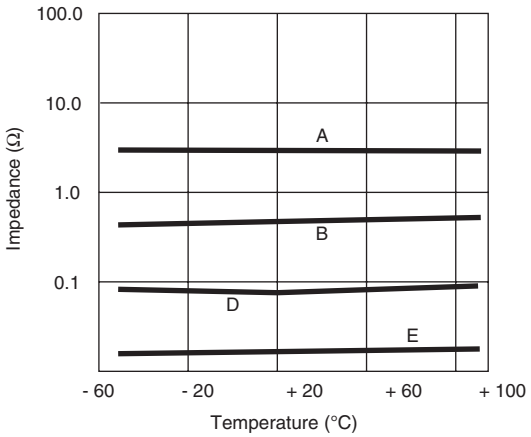
Temperature vs. Capacitance Change
(120 Hz)



Temperature vs. Leakage Current
(Rated Voltage)



Temperature vs. Impedance
(100 kHz)



A = 1 µF/25 WV B = 10 µF/10 WV C = 10 µF/16 WV D = 47 µF/6.3 WV E = 100 µF/16 WV F = 150 µF/16 WV

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

HIGH TEMPERATURE LOAD (at + 105 °C)

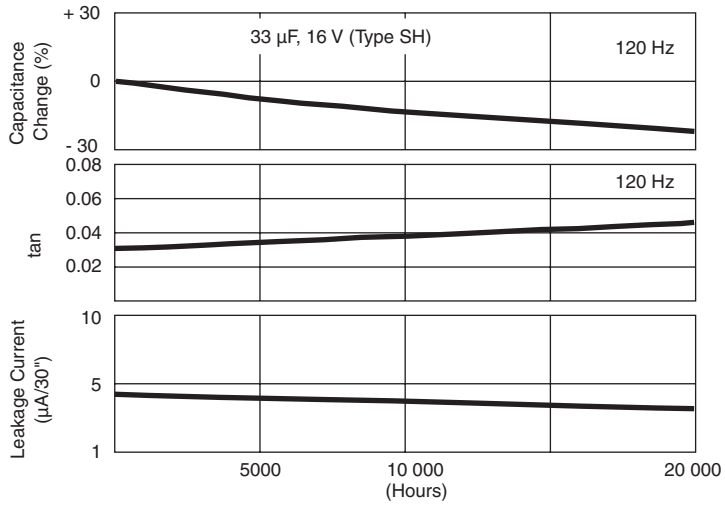


Figure 1

Figure 1 shows a graph with the tendency of each characteristic of the Vishay OS-CON capacitor on high-temperature load test. The change in capacitance shows a tendency for reduction as that of the aluminum electrolytic capacitor does. However, with the aluminum electrolytic capacitor there is a yield point (time) depending on the dry-up of the electrolytic solution, but with the Vishay OS-CON capacitor, there is not such a phenomenon, and the tendency for gradual decrease continues semi-permanently.
The change in standing almost never differs in the presence of voltage application except for the change of leakage current.

TEMPERATURE ACCELERATION TEST (high-temperature load)

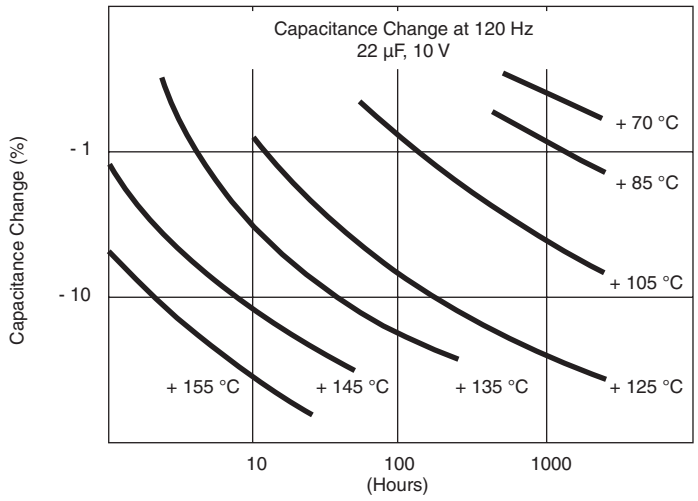


Figure 2

The decrease of capacitance causes a failure in the lifetime of the Vishay OS-CON capacitor. The capacitance decreases mainly due to temperature. Figure 2 shows the decreasing speed in capacitance at each temperature. From this, the temperature coefficient of the Vishay OS-CON capacitor's lifetime becomes 10 times at 20 °C reduction. The temperature coefficient of the aluminum electrolytic capacitor becomes twice at 10 °C reduction compared to that in the usual lifetime.
This indicates that, for instance, their deterioration at + 105 °C x 2000 hours, can be converted into those at + 105 °C, + 85 °C and + 65 °C as follows:

Estimation of Life Time:	Vishay OS-CON Capacitor	Aluminum Electrolytic Capacitor
	+ 105 °C = 2000 hours	+ 105 °C = 2000 hours
	+ 85 °C = 20 000 hours	+ 85 °C = 8000 hours
	+ 65 °C = 200 000 hours (22 years)	+ 65 °C = 32 000 hours (3.6 years)

(These are estimated values, not actual amounts that can be guaranteed.)
This means that the Vishay OS-CON capacitor has extremely longer life in practical use even for + 105 °C x 2000 hours, guaranteed products.

RELIABILITY PRESUMPTION OF LIFE

The Vishay OS-CON capacitor, as pointed out on previous page, loses capacitance as times goes by, as shown in Figure 1. From this, the wear-out failure of the Vishay OS-CON leads to an open mode by decreasing of the capacitance. This wear-out failure by the decrease of the capacitance mainly causes the failure of a Vishay OS-CON capacitor. The occurrence time of this wear-out failure (lifetime) varies according to the ambient temperature in which the products are used, also selfheating temperature through the flow of Ripple Current. Estimate of a Vishay OS-CON capacitor's life is approximately 10 times at 20 °C reduction. The estimated life L_x (hours) of a Vishay OS-CON capacitor at ambient Temperature T_x (°C) may be roughly expressed by the following equation:

$$L_x = L_o \times 10^{\frac{T_o - (T_X + \Delta T_X)}{20}}$$

L_x = Life Expectance (hours) in actual use (Temperature T_x)
L_o = Guaranteed (hours) at maximum temperature in use
T_o = Maximum operating temperature
T_x = Temperature in actual use (°C)
ΔT^x = Self-heating temperature by Ripple Current (°C)
$\Delta T_x = (Ix/Io)^2 \times \Delta T\ Ix \leq Io$
I_o = Maximum allowable Ripple Current at + 45 °C or less (A_{rms})
I_x = Actual flow of Ripple Current (A_{rms})

Self heating value ΔT by maximum allowable Ripple Current (+ 45 °C or less) varies according to case size. Refer to the rough values in the chart below:

Case Size	A, A'	B, B'	C, C'	D	E, E'	F, F', F_o	G	H
ΔT (°C)	8	10	15	16	18	20	20	20

This estimation comes out of presumed values based on actual measurement results, which does NOT guarantee the entire production lots.

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

EXPLANATION OF THE RUSH CURRENT SUPPRESSION METHODS

There is the chance that an excessive amount of rush current will flow through the Vishay OS-CON capacitor when it is used in the following circuits because its ESR is exceedingly low. Therefore, careful consideration and measures must be taken with regard to design and production equipment. Use the Vishay OS-CON capacitor so the rush current value does not exceed 10 A.
In case that 10 times the allowable ripple current value exceeds 10 A, the Vishay OS-CON capacitor can be used within that value.

1. DC/DC Converter Input Circuits

a. DC/DC converter circuits are usually a PC board block shape and use a low ESR capacitor in the input section for high performance and miniaturization.

b. Consideration must be given to the rush current that flows the equipment when dc-to-dc converter is adjusted and inspected.

- There is the possibility that an extremely large amount of rush current will flow through the Vishay OS-CON capacitor during voltage adjustment or inspection of the dc-to-dc converter's circuit block when the power impedance supplied from the equipment being adjusted or inspected is exceedingly low and the current suppression function of the current limiter and such is provided.

  (Refer to the example in Figure 1.)

- Rush current suppression measures must be taken for dc-to-dc converter adjustment and inspection equipment.

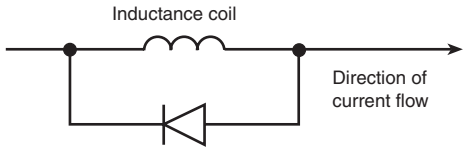
2. Circuits Driven by Chargeable Batteries

b. Circuit power lines equipped with batteries or rechargeable batteries use capacitors such as the Vishay OS-CON with very low ESR to increase performance and facilitate miniaturization.

- There is the possibility of an extremely large amount of rush current flowing through the low ESR capacitors arranged along the power line when the power is turned on for circuits driven by nickel cadmium chargeable batteries and such that have a very low internal resistance.

  (Refer to the example in Fig.1.)

- A protection circuit like that is shown at the top of the next column is usually used to suppress rush current of charging battery.



Diode for absorbing counter electromotive force

The main points to be aware of are listed here.

- Normally, an inductance coil with a magnetic core is used; however, inductance sometimes drops depending on the frequency, so it must be checked.
- The peak current value of the diode when absorbing counter electromotive force.

3. No Protection Resistance Rush Current

When there is no protection, Resistor Z as shown in Fig.1 and the power supply has Re = 0 Ω, the Vishay OS-CON capacitor's rush current is as follows.

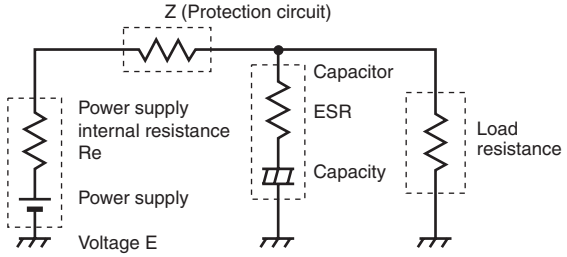
$$\text{Rush current (A)} = \frac{\text{Supplied DC voltage (E)}}{\text{ESR + Re + Z (}\Omega\text{)}}$$

Example:

For type 94SC106X0025C
ESR = Less than 90 mΩ, and
supplied DC voltage = 20 V,

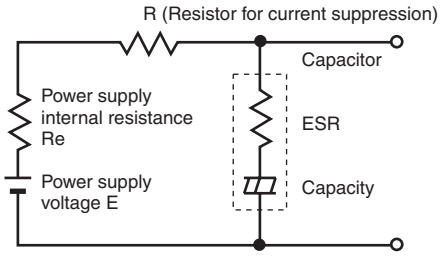
$$\frac{\text{Then 20 V}}{\text{Less than 0.09 }\Omega} = \text{more than 222A}$$

Fig.1



EXAMPLE OF RUSH CURRENT SUPPRESSION METHODS

1. Resistor Method

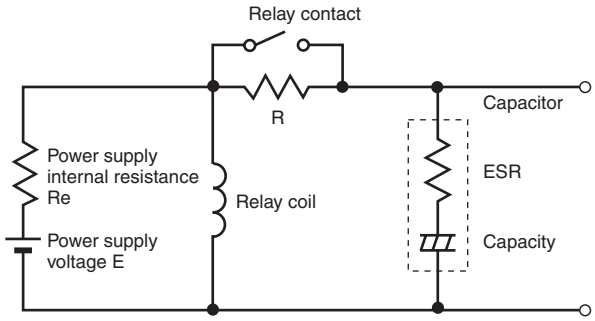


- Rush Current is as shown below.

$$\text{Rush current (A)} = \frac{\text{E (V)}}{\text{Re + ESR + R } (\Omega)}$$

- Rush Current is usually determined mainly by R, as Re and ESR are low.
- Although the current is simply and clearly suppressed with this method, resistor R is suppressing current causes the voltage to drop.

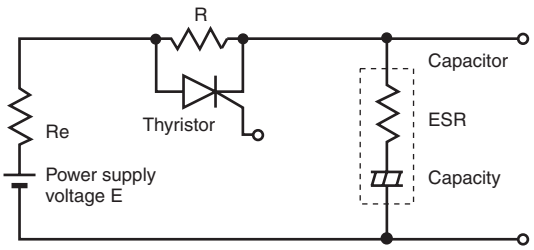
2. Resistor and Relay Method



- The Rush Current is exactly the same as in the resistor method, however, there is almost no voltage drop caused by the current suppression resistor from the time the relay contact goes ON.
- Note that the relay MUST be changed depending on the voltage of the supplied power.

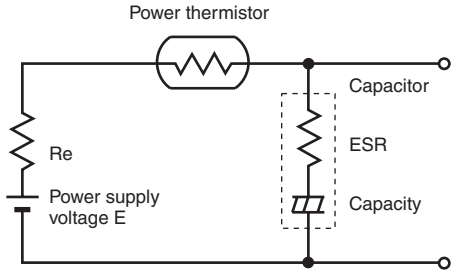
  This is mainly because the relay coil's specifications differ depending on the voltage.

3. Resistor and Thyristor Method



- Rush Current is exactly the same as in the resistor method, however, there is almost no voltage drop caused by R after rushing, the same as the resistor and relay method.

4. Power Thermistor



- Taking an example of a power thermistor sold on the market, the value is 8 Ω at + 25 °C, but becomes - 0.62 Ω at + 130 °C.
- When the power thermistor is connected as shown in the above diagram, rush current is suppressed due to the large resistor value at the moment the switch is turned on.

  After this, the output loss (voltage drop) is reduced.

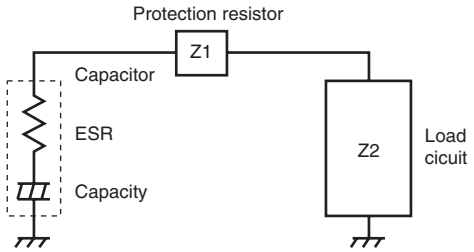
  However, the power thermistor has a heat constant, meaning that the large resistor value in the initial state cannot be regained the moment the switch is turned off.

  As a result, the ability to suppress current is lost when the switch is turned off and on quickly.

SUDDEN DISCHARGE CURRENT SUPPRESSION METHODS

Since the Vishay OS-CON capacitor has an exceedingly low ESR and when the load impedance during discharge is extremely low, there is the chance that it allows a large amount of discharge current to flow for an instant.
Please note the following points when using Vishay OS-CON capacitor in sudden discharge operations.

The discharge equivalent circuit is as shown below.



As shown in the above example, there is the chance an extremely large amount of discharge current will flow when electric charge is discharged with 0 Ω loading. When the Vishay OS-CON capacitor is to be used in sudden discharge operations, use the above mentioned formula to estimate the discharge current.

Use the Vishay OS-CON capacitor so the peak discharge current value does not exceed 10 A. In case that 10 times of the allowable ripple current value exceeds 10 A, the Vishay OS-CON capacitor can be used within the value.

The formula for estimating discharge current is given below.

$$\text{Discharge current (A)} = \frac{\text{Charging voltage (V)}}{\text{ESR + Z1 + Z2 (}\Omega\text{)}}$$

Example:

For type 94SC106X0025C
ESR = Less than 90 mΩ
Charging voltage = 20 V
Z1, Z2 = 0 Ω
} is set, then

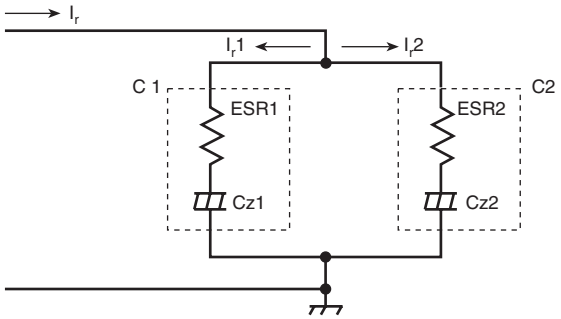
$$\text{Discharge current (A)} = \frac{\text{Charging voltage (V)}}{\text{ESR + Z1 + Z2 (}\Omega\text{)}}$$

$$= \frac{\text{Then 20 V}}{\text{Less than 0.09 }\Omega} = \text{more than 222 A}$$

CONNECTING A VISHAY OS-CON AND AN ALUMINUM ELECTROLYTIC CAPACITOR IN PARALLEL

Aluminum electrolytic capacitors and Vishay OS-CON capacitors are often connected in parallel to improve the space factor and cost performance of ripple absorbing capacitors. Please give full consideration to the following.

Fig.1



I_r = Total Ripple Current
ESR = Capacitor's Equivalent Series Resistance
Cz = Impedance of the capacitor's capacitive components

Ripple current flowing through each parallel connected capacitor can be found by using the values symbolized in the reference equivalent circuit in Fig.1.

The equivalent circuit in Fig.1 can be simplified as shown in Figure 2 when it is to be used for frequencies between 100 kHz and a few MHz. (Assuming the capacitor's capacity is more than 10 µF.)

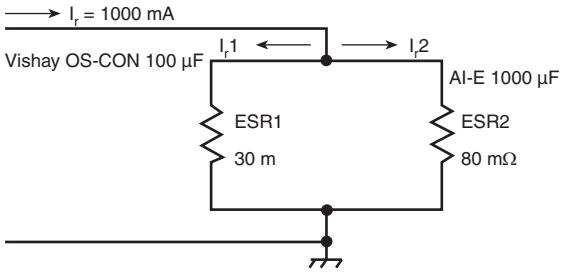


Fig.2

Since impedance becomes exceedingly low when the capacity is more than 10 µF, and frequencies higher than 100 kHz, each Cz in Fig. 1 can be omitted changing the actual ripple current value to that shown Fig.2.

$$Ir\ 1 = Ir \times \frac{ESR2}{ESR1 + ESR2}$$

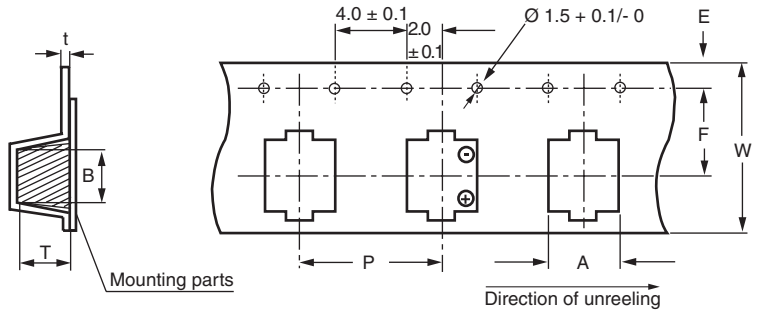
$$= 1000\text{ mA} \times \frac{80\text{ m}\Omega}{30\text{ m}\Omega + 80\text{ m}\Omega} = 727\text{ mA}$$

As shown here, although the Vishay OS-CON capacitor has 1/10th of the capacity of that the mated capacitor, it allows 73 % of the ripple current flow.

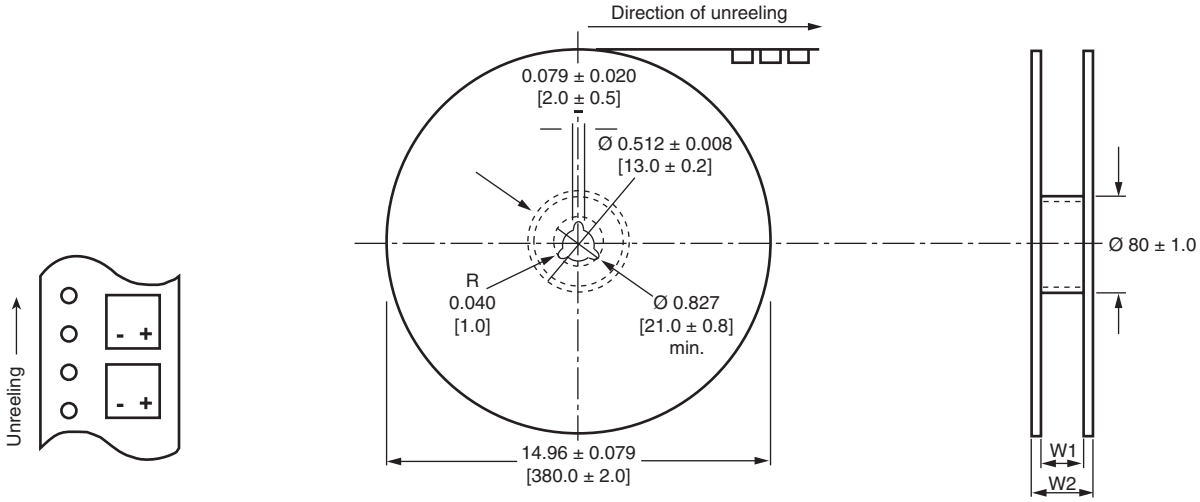
As explained here, when a Vishay OS-CON capacitor and an aluminum electrolytic capacitor are to be used in parallel connection, select the appropriate type of Vishay OS-CON capacitor that has an extra margin of capacity since a large amount of ripple current flows through it.

Type 94SVP/94SVPD Solid Aluminum Capacitors with Organic Semiconductor Electrolyte Surface Mount Chip

TAPING SPECIFICATIONS FOR AUTOMATIC INSERTING MACHINES



DIMENSIONS in millimeters								
SIZE CODE	**A**	**B**	**W**	**F**	**E**	**P**	**t**	**T**
A5	4.7 ± 0.2	4.7 ± 0.2	12.0 ± 0.3	5.5 ± 0.1	1.75 ± 0.1	8.0 ± 0.1	0.4 ± 0.1	5.8 ± 0.2
B6	5.6 ± 0.2	5.6 ± 0.2	16.0 ± 0.3	7.5 ± 0.1	1.75 ± 0.1	8.0 ± 0.1	0.4 ± 0.1	6.2 ± 02
C6	6.9 ± 0.2	6.9 ± 0.2	16.0 ± 0.3	7.5 ± 0.1	1.75 ± 0.1	12.0 ± 0.1	0.4 ± 0.1	6.2 ± 0.2
E7	8.6 ± 0.2	8.6 ± 0.2	24.0 ± 0.3	11.5 ± 0.1	1.75 ± 0.1	12.0 ± 0.1	0.4 ± 0.1	7.2 ± 0.2
F8	10.7 ± 0.2	10.7 ± 0.2	24.0 ± 0.3	11.5 ± 0.1	1.75 ± 0.1	16.0 ± 0.1	0.4 ± 0.1	8.2 ± 0.2
E12	8.6 ± 0.2	8.6 ± 0.2	24.0 ± 0.3	11.5 ± 0.1	1.75 ± 0.1	16.0 ± 0.1	0.4 ± 0.1	12.3 ± 0.2
F12	10.7 ± 0.2	10.7 ± 0.2	24.0 ± 0.3	11.5 ± 0.1	1.75 ± 0.1	16.0 ± 0.1	0.4 ± 0.1	13.0 ± 0.2



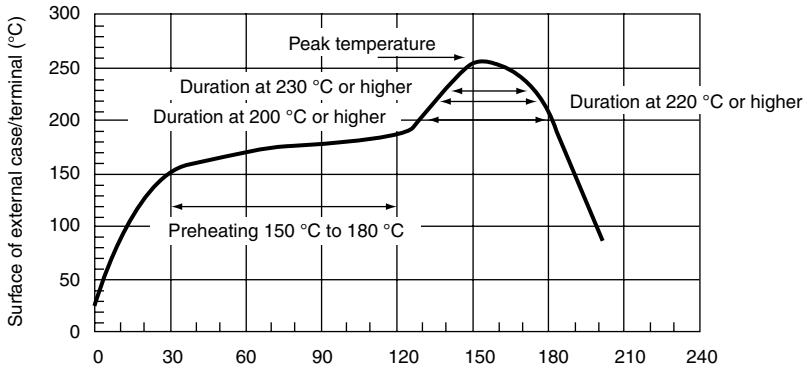
DIMENSIONS in millimeters		
SIZE CODE	**W1**	**W2**
A5	13.0 ± 0.5	17.5 ± 1.0
B6, C6	17.0 ± 0.5	21.5 ± 1.0
E7, F8, E12, F12	25.0 ± 0.5	29.5 ± 1.0

MINIMUM PACKING QUANTITY	
SIZE CODE	**PCS/REEL (Ø 380)**
A5	2000
B6	1500
C6	1000
E7	1000
F8	500
E12	400
F12	400

Type 94SVP/94SVPD Solid Aluminum Capacitors with Organic Semiconductor Electrolyte Surface Mount Chip

RECOMMENDED REFLOW PROFILE

Recommended reflow profile



Vishay OS-CON has different characteristics against soldering heat from conventional aluminum electrolytic capacitors or tantalum capacitors because of its unique materials and structure.

Please note the following points on soldering of Vishay OS-CON 94SVP/94SVPD series to draw out the best performance.

ITEM	94SVP/94SVPD SERIES	
Peak temperature (max.)	250 °C	260 °C
Preheat	150 °C to 180 °C 90 ± 30 s	
200 °C over time (max.)	60 s	60 s
220 °C over time (max.)	50 s	50 s
230 °C over time (max.)	40 s	40 s
Reflow number	twice or less	only 1 time

Note

All temperatures are measured on the topside of the Al-can and terminal surface.

Attention:

Reflow soldering may reduce the capacitance of products before or after soldering even if soldering conditions stipulated in Recommended Reflow Condition are met. Though the actual reflow conditions are subject to change depending on the kind of reflow soldering method, please be aware that the peak temperature at the top of Al-case and electrode terminals should not exceed peak temperature. Particular notice should be given to the time that Vishay OS-CON is heated at 200 °C or higher during reflow. Be aware that soldering considerably deviating from these conditions will cause problems such as a 50 % reduction in capacitance, and a considerable increase in leakage current.

The leakage current value may increase (from a few µA to a few mA) even within the above conditions. When the Vishay OS-CON is used in a DC circuit, the leakage current will decrease gradually through self-recovery after voltage is applied. If your reflow profile (reflow temperature, number of reflows, etc.) deviates from the above conditions for mounting the 94SVP/94SVPD series, please consult with Vishay OS-CON.

STORAGE OF TYPE 94SVP/94SVPD:

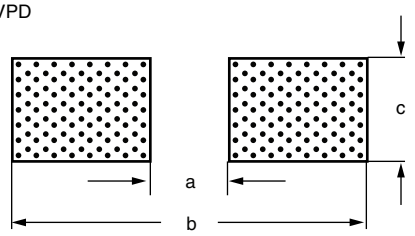
It is necessary to store these capacitors in a proper environment to prevent problems (degradation of solderability or appearance) when soldering. Keep these capacitors sealed in the reel and storage bag as delivered and store in the following environment:

- Room temperature and room humidity (generally + 15 °C to 25 °C, 45 % to 75 % RH).
- Place where capacitors are not exposed to direct sunshine.
- Also, set storage period at 6 months or shorter.

Unseal just before mounting. Return any remaining parts to storage bag and reseal bag securely with tape.

RECOMMENDED LAND PATTERN

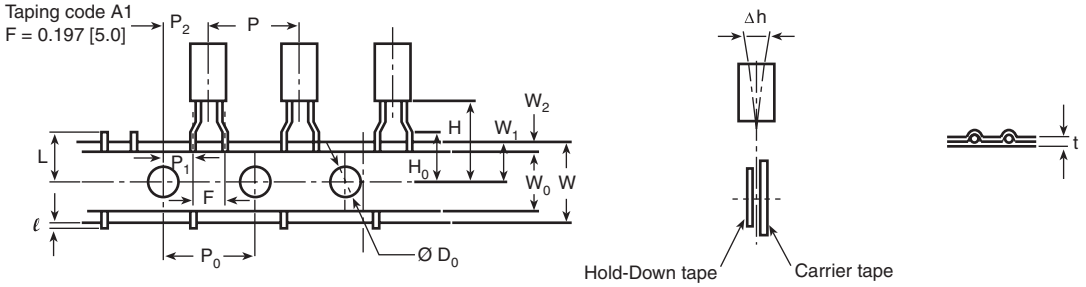
Type 94SVP/94SVPD

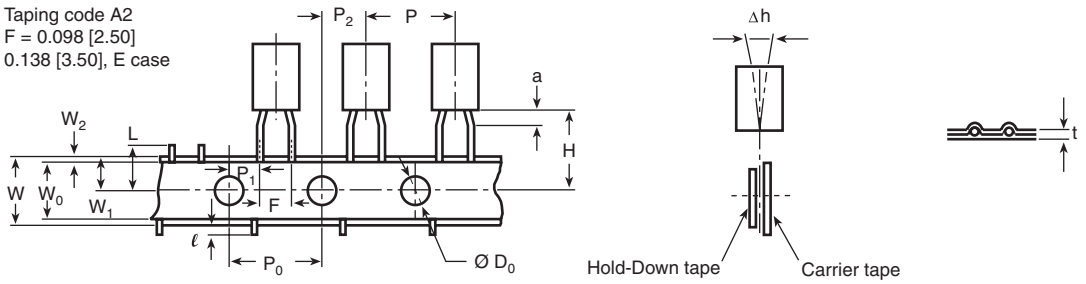


DIMENSIONS in millimeters			
CASE CODE	**a**	**b**	**c**
A5	1.0	6.2	1.6
B6	1.4	7.4	1.6
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9
F8	4.3	13.1	1.9
E12	2.8	11.1	1.9
F12	4.3	13.1	1.9

Types 94SC/SA/SL/SS/SP Solid Aluminum Capacitors with Organic Semiconductors Electrolyte

TAPING SPECIFICATIONS FOR AUTOMATIC INSERTING MACHINES in inches [millimeters]										
TAPING CODE		**A1**	**A1**	**A1**	**A1**	**A1**	**A2**	**A2**	**A2**	**A2**
SYMBOL	**TOLERANCE**	**Ø 0.157 [Ø 4.0]**	**Ø 0.197 [Ø 5.0]**	**Ø 0.248 [Ø 6.3]**	**Ø 0.315 [Ø 8.0]**	**Ø 0.394 [Ø 10.0]**	**Ø 0.157 [Ø 4.0]**	**Ø 0.197 [Ø 5.0]**	**Ø 0.248 [Ø 6.3]**	**Ø 0.315 [Ø 8.0]**
F	+ 0.031 - 0.008 [+ 0.8 - 0.2]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]	0.138 [3.5]
P	± 0.040 [± 1.0]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]
P_0	± 0.008 [± 0.2]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]	0.5 [12.7]
P_1	± 0.020 [± 0.5]	0.152 [5.0]	0.152 [5.0]	0.152 [5.0]	0.152 [5.0]	0.152 [5.0]	0.201 [5.1]	0.201 [5.1]	0.201 [5.1]	0.181 [4.60]
P_2	± 0.040 [± 1.0]	0.250 [6.35]	0.250 [6.35]	0.250 [6.35]	0.250 [6.35]	0.250 [6.35]	0.250 [6.35]	0.250 [6.35]	0.250 [6.35]	0.250 [6.35]
Δh	± 0.040 [± 1.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]
W	± 0.020 [± 0.5]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0	min.	0.374 [9.5]	0.374 [9.5]	0.374 [9.5]	0.374 [9.5]	0.374 [9.5]	0.374 [9.5]	0.374 [9.5]	0.374 [9.5]	0.374 [9.5]
W_1	± 0.020 [± 0.5]	0.354 [9.0]	0.354 [9.0]	0.354 [9.0]	0.354 [9.0]	0.354 [9.0]	0.354 [9.0]	0.354 [9.0]	0.354 [9.0]	0.354 [9.0]
W_2	max.	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]	0.098 [2.5]
H	± 0.030 [± 0.75]	0.728 [18.5]	0.728 [18.5]	0.728 [18.5]	0.787 [20.0]	0.728 [18.5]	0.690 [17.5]	0.690 [17.5]	0.690 [17.5]	0.690 [17.5]
H_0	± 0.020 [± 0.5]	0.630 [5.0]	0.630 [5.0]	0.630 [5.0]	0.630 [5.0]	-	-	-	-	-
Ø D_0	± 0.008 [± 0.2]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]	Ø 0.157 [Ø 4.0]
t	± 0.008 [± 0.2]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]
ℓ	max.	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]	0.0 [0.0]
L	max.	0.433 [11.0]	0.433 [11.0]	0.433 [11.0]	0.433 [11.0]	0.433 [11.0]	0.433 [11.0]	0.433 [11.0]	0.433 [11.0]	0.433 [11.0]
a	max.	-	-	-	-	-	0.58 [1.5]	0.58 [1.5]	-	-





Vertical Surface Mounting Capacitors

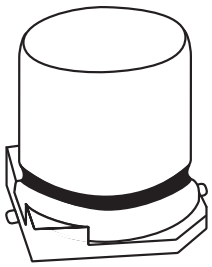


Fig.1 Component outline

FEATURES

- New Vishay OS-CON series as results of polymerized organic semiconductor as electrolyte
- Features superior heat-proof characteristics compared with previously developed Vishay OS-CON series
- Particularly effective when used as surface mounting devices of the switching power supply
- Rated ripple current values are guaranteed at 105 °C
- No need to consider derating on maximum allowable ripple current

Pb-free
RoHS COMPLIANT

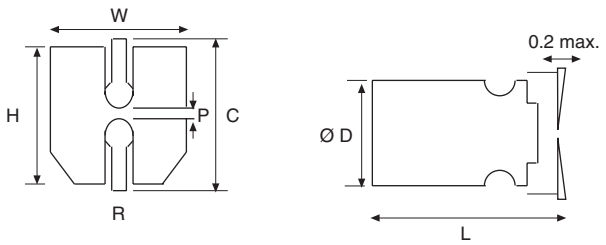
QUICK REFERENCE DATA			
DESCRIPTION	**VALUE**		
Operating temperature range	- 55 °C to + 105 °C		
Capacitance tolerance at 120 Hz	M: ± 20 %		
Tangent of loss angle (tan δ) at 120 Hz	values in standard ratings table		
Leakage current (μA/2 minutes) (or less) (1)	values in standard ratings table		
Equivalent series resistance (Ω), (100 k to 300 kHz)	values in standard ratings table		
Characteristics at high temp. and low temp. Impedance ratio at 100 kHz, + 20 °C	- 55 °C	$Z/Z_{20\ °C}$	1.0 to 1.25
	+ 105 °C	$Z/Z_{20\ °C}$	0.75 to1.0
Endurance + 105 °C, 2000 hours Rated voltage applied (25 WV to 20 V) (1000 hours for A5/B6 sizes)	ΔC/C	within ± 20 %	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	ESR	≤ 1.5 x the value of ESR	
	leakage current	≤ the value of leakage current	
Damp heat (steady state) (+ 60 °C, 90 to 95 % RH, 1000 hours, no voltage) (500 hours for A5/B6 sizes)	ΔC/C	within ± 20 %	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	ESR	≤ 1.5 x the value of ESR	
	leakage current	≤ the value of leakage current after voltage treatment	
Reverse voltage guarantee	temporary: < 20 % of the rated voltage continuous: < 10 % of the rated voltage		
Solder heat resistance (VPS) (2) (215 °C x 90 s) or (230 °C x 60 s) (Please consult us for A5/B6 sizes)	ΔC/C	within ± 10 %	
	tan δ	≤ 1.3 x the value of tangent of loss angle	
	ESR	≤ 1.3 x the value of ESR	
	leakage current	≤ the value of leakage current after voltage treatment	

Notes

(1) If any doubt arises, measure the current after applying voltage (voltage treatment). Voltage Treatment: The rated voltage is applied to Vishay OS-CON (2.5 to 20 WV) for 120 minutes at 105 °C. (However, 20 V is applied to a 25 WV Vishay OS-CON).

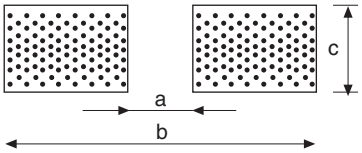
(2) Refer to Standard Ratings table for soldering recommendation.

DIMENSIONS in millimeters



DIMENSIONS in millimeters							
SIZE CODE	**Ø D ± 0.5**	**L max.**	**W ± 0.2**	**H ± 0.2**	**C ± 0.2**	**R**	**P ± 0.2**
A5	4.0	5.5	4.3	4.3	5.0	0.5 to 0.8	1.0
B6	5.0	6.0	5.3	5.3	6.0	0.5 to 0.8	1.4
C6	6.3	6.0	6.6	6.6	7.3	0.5 to 0.8	2.1
E7	8.0	7.0	8.3	8.3	9.0	0.5 to 0.8	3.2
F8	10.0	8.0	10.3	10.3	11.0	0.5 to 0.8	4.6
E12	8.0	12.0	8.3	8.3	9.0	0.8 to 1.1	3.2
F12	10.0	12.7	10.3	10.3	11.0	0.8 to 1.1	4.6

RECOMMENDED LAND PATTERN



DIMENSIONS in millimeters			
SIZE CODE	a	b	c
A5	1.0	6.2	1.6
B6	1.4	7.4	1.6
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9
F8	4.3	13.1	1.9
E12	2.8	11.1	1.9
F12	4.3	13.1	1.9

CASE CODE LIST

WV [1] / (SV) [2]	2.5	4	6.3	10	16	20	25
CAPACITANCE (µF)	(3.3)	(5.2)	(8.2)	(11.5)	(18.4)	(23)	(25)
3.3	-	-	-	-	A5	-	-
4.7	-	-	-	A5	-	-	-
6.8	-	-	-	A5	-	-	C6
10.0	-	-	-	A5	-	B6	E7
15.0	-	-	-	A5	B6	-	-
27.0	-	-	-	-	-	C6	-
22.0	-	-	A5	-	B6	C6	F8
33.0	-	A5	-	B6	-	E7	E12
39.0	-	B6	-	-	C6	-	-
47.0	-	-	B6	C6	-	E7	-
56.0	-	-	-	C6	E7	F8	F12
68.0	-	B6	-	-	-	F8	-
82.0	-	-	C6	-	E7	-	-
100.0	-	-	C6	-	F8	E12	-
120.0	-	-	-	E7	-	-	-
150.0	-	C6, E7	-	E7, F8	F8	F12	-
180.0	-	-	-	-	E12	-	-
220.0	-	-	E7, F8	-	-	-	-
270.0	-	-	-	E7, F8	-	-	-
330.0	-	E7	F8	E12	F12	-	-
470.0	-	-	F8,E12	-	-	-	-
560.0	-	E12	-	F12	-	-	-
680.0	E12	F8	-	-	-	-	-
820.0	-	-	F12	-	-	-	-
1200.0	-	F12	-	-	-	-	-
1500.0	F12	-	-	-	-	-	-

Notes

[1] WV = Rated Voltage.

[2] (SV) = Surge Voltage (at room temperature). The description contents are subject to chage due to technical improvement without notice. Please ask for latest specifications for order and use.

STANDARD RATINGS

CASE CODE	PART NUMBER [1]	RATED VOLTAGE (V)	RATED CAPACITANCE (µF)	MAX. ESR (100 kHz to 300 kHz) (mΩ)	ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 105 °C	MAX. TANGENT OF LOSS ANGLE	MAX. LEAKAGE CURRENT (µA) (after 2 min)
A5	94SVP335X0016A5	16	3.3	280	590	0.07	26.4
	94SVP475X0010A5	10	4.7	260	660	0.08	23.5
	94SVP685X0010A5	10	6.8	260	660	0.09	34.0
	94SVP106X0010A5	10	10	240	670	0.10	50.0
	94SVP156X0010A5	10	15	240	670	0.10	75.0
	94SVP226X06R3A5	6.3	22	220	700	0.12	69.3
	94SVP336X0004A5	4	33	200	740	0.15	66.0

Note

[1] Part Numbers shown are for ± 20 % capacitance tolerance (X0).

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	RATED CAPACITANCE (µF)	MAX. ESR (100 kHz to 300 kHz) (mΩ)	ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 105 °C	MAX. TANGENT OF LOSS ANGLE	MAX. LEAKAGE CURRENT (µA) (after 2 min)
B6	94SVP106X0020B6	20	10	170	850	0.10	100
	94SVP156X0016B6	16	15	150	920	0.10	120
	94SVP226X0016B6	16	22	150	920	0.15	176
	94SVP336X0010B6	10	33	130	990	0.15	165
	94SVP476X06R3B6	6.3	47	90	1060	0.15	148
	94SVP396X0004B6	4	39	70	1100	0.15	78
	94SVP686X0004B6	4	68	70	1100	0.15	136
C6	94SVP685X0025C6	25	6.8	80	1200	0.10	85
	94SVP226X0020C6	20	22	65	1390	0.10	88
	94SVP276X0020C6	20	27	60	1450	0.10	108
	94SVP396X0016C6	16	39	65	1390	0.10	125
	94SVP476X0010C6	10	47	60	1450	0.12	94
	94SVP566X0010C6	10	56	55	1510	0.12	112
	94SVP107X06R3C6	6.3	100	40	1810	0.12	126
	94SVP826X06R3C6	6.3	82	50	1570	0.12	103
	94SVP157X0004C6	4	150	50	1620	0.12	120
E7	94SVP106X0025E7	25	10	60	1500	0.10	125
	94SVP336X0020E7	20	33	50	1700	0.12	132
	94SVP476X0020E7	20	47	50	1700	0.12	188
	94SVP566X0016E7	16	56	50	1800	0.12	179
	94SVP826X0016E7	16	82	45	1890	0.12	262
	94SVP127X0010E7	10	120	40	2120	0.12	240
	94SVP157X0010E7	10	150	35	2560	0.12	300
	94SVP157X0004E7	4	150	35	2350	0.12	120
	94SVP337X0004E7	4	330	35	2560	0.12	264
	94SVP227X06R3E7	6.3	220	35	2560	0.12	277
F8	94SVP226X0025F8	25	22	50	2000	0.10	275
	94SVP566X0020F8	20	56	45	2200	0.12	224
	94SVP686X0020F8	20	68	45	2200	0.12	272
	94SVP107X0016F8	16	100	40	2400	0.12	320
	94SVP157X0016F8	16	150	35	2670	0.12	480
	94SVP157X0010F8	10	150	35	2670	0.12	300
	94SVP277X0010F8	10	270	30	3020	0.12	540
	94SVP227X06R3F8	6.3	220	30	3020	0.12	277
	94SVP477X06R3F8	6.3	470	25	3700	0.12	592
	94SVP337X06R3F8	6.3	330	25	3300	0.12	416
	94SVP687X0004F8	4	680	25	3700	0.12	544
E12	94SVP336X0025E12	25	33	30	2980	0.12	413
	94SVP107X0020E12	20	100	25	3260	0.15	400
	94SVP187X0016E12	16	180	22	3480	0.15	576
	94SVP337X0010E12	10	330	19	3740	0.15	660
	94SVP477X06R3E12	6.3	470	17	3960	0.15	592
	94SVP567X0004E12	4	560	16	4080	0.15	448
	94SVP687X02R5E12	2.5	680	16	4080	0.15	340
F12	94SVP566X0025F12	25	56	28	3800	0.12	700
	94SVP157X0020F12	20	150	21	4220	0.15	600
	94SVP337X0016F12	16	330	17	4580	0.15	792
	94SVP567X0010F12	10	560	15	4870	0.15	840
	94SVP827X06R3F12	6.3	820	14	5040	0.15	775
	94SVP128X0004F12	4	1200	13	5230	0.18	960
	94SVP158X02R5F12	2.5	1500	13	5230	0.18	750

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).

94SVPD

Vishay OS-CON

Aluminum Solid Capacitors with Conductive Polymer

FEATURES

- New OS-CON 94SVPD series provides improved characteristics with up to 125 °C temperature capability and 35 V maximum voltage rating in a SMD package
- Improved damp heat (steady state) 85 °C x 85 % RH performance
- Suitable for use in smoothing circuits of vehicle-mounted equipment, industrial equipment, etc.
- This product can support lead (Pb)-free reflow (2)

Pb-free

RoHS COMPLIANT

QUICK REFERENCE DATA

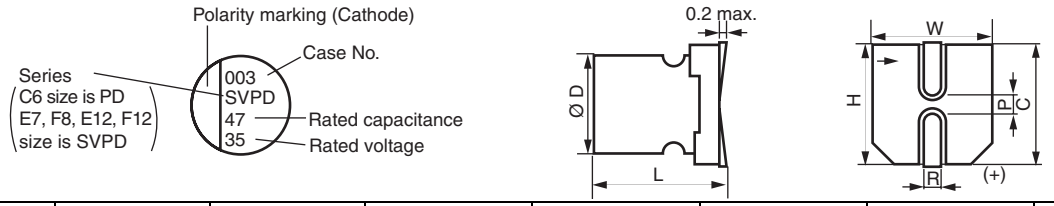
DESCRIPTION	CONDITIONS	VALUE		
Operating temperature range	-	- 55 °C to + 125 °C		
Capacitance tolerance	120 Hz	M: ± 20 %		
Tangent of loss angle (tan δ)	120 Hz	≤ values in standard ratings table		
Leakage current (μA/2 min) (or less) (1)	after 2 minutes	≤ values in standard ratings table		
ESR	-	≤ values in standard ratings table		
Characteristics of impedance ratio at high and low temperature	at 100 kHz, + 20 °C	- 55 °C	$Z/Z_{20\ °C}$	0.75 to 1.25
		+ 125 °C	$Z/Z_{20\ °C}$	0.75 to 1.0
Endurance	+ 125 °C, 2000 h rated voltage applied	ΔC/C	within ± 20 %	
		tan δ	2 x or < than an initial standard	
		ESR	2 x or < than an initial standard	
		Leakage current	below an initial standard	
Damp heat (Steady state)	+ 85 °C, 85 to 90 % RH, 1000 h rated voltage applied	ΔC/C	within ± 20 %	
		tan δ	2 x or < than an initial standard	
		ESR	2 x or < than an initial standard	
		Leakage Current	below an initial standard	
Solder heat resistance (2)	(VPS) (230 °C x 75 s)	ΔC/C	within ± 10 %	
		tan δ	1.3 x or < than an initial standard	
		ESR	1.3 x or < than an initial standard	
		Leakage Current	below an initial standard (after voltage procesing)	

Notes

(1) If any doubt arises, measure the current after applying voltage (voltage treatment). Voltage Treatment: the rated voltage is applied (10 to 35 V) for 120 minutes at 125 ºC.

(2) Refer to RECOMMENDED REFLOW PROFILE for maximum temperatures

DIMENSIONS in millimeters

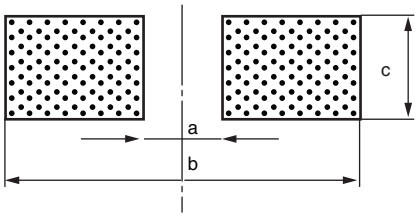


SIZE CODE	Ø D ± 0.5	L + 0.1 - 0.4	W ± 0.2	H ± 0.2	C ± 0.2	R	P ± 0.2
C6	6.3	5.9	6.6	6.6	7.3	0.6 to 0.8	2.1
E7	8.0	6.9	8.3	8.3	9.0	0.6 to 0.8	3.2
F8	10.0	7.9	10.3	10.3	11.0	0.6 to 0.8	4.6
E12	8.0	11.9	8.3	8.3	9.0	0.8 to 1.1	3.2
F12	10.0	12.6	10.3	10.3	11.0	0.8 to 1.1	4.6

CASE CODE LIST

CAPACITANCE (µF)	RATED VOLTAGE (SURGE AT 125 °C)			
	10.0 (11.5)	16.0 (18.4)	25.0 (29.0)	35.0 (40.0)
8.2				E7
10			C6	
18				F8
22			E7	E12
39			F8	
47			E12	F12
56	C6			
82		E7	F12	

RECOMMENDED LAND PATTERN (dimensions in mm)



SIZE CODE	a	b	c
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9
F8	4.3	13.1	1.9
E12	2.8	11.1	1.9
F12	4.3	13.1	1.9

FREQUENCY COEFFICIENT FOR RIPPLE CURRENT

FREQUENCY	120 Hz ≤ f < 1 kHz	1 kHz ≤ f < 10 kHz	10 kHz ≤ f < 100 kHz	100 kHz ≤ f < 500 kHz
COEFFICIENT	0.05	0.3	0.7	1

STANDARD RATINGS

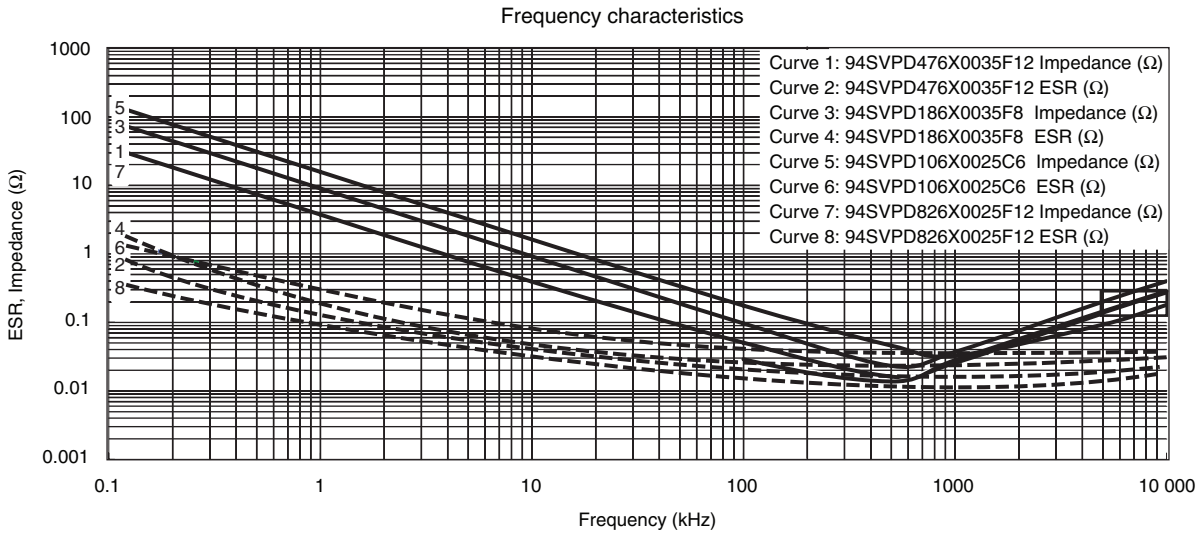
CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	RATED CAP. (µF)	MAX. ESR (100 k to 300 kHz) (mΩ)	RATED RIPPLE CURRENT	ALLOWABLE RIPPLE CURRENT	MAX. TANGENT OF LOSS ANGLE	MAX. LEAKAGE CURRENT (µA) (2)
					100 kHz (mA) (3)			
					105 °C < Tx ≤ 125 °C	Tx ≤ 105 °C		
C6	94SVPD106X0025C6	25	10	65	474	1500	0.10	50
	94SVPD566X0010C6	10	56	45	538	1700	0.12	112
E7	94SVPD825X0035E7	35	8.2	70	400	1300	0.10	57
	94SVPD226X0025E7	25	22	48	580	1835	0.10	110
	94SVPD826X0016E7	16	82	40	670	2120	0.12	262
F8	94SVPD186X0035F8	35	18	60	550	1800	0.10	126
	94SVPD396X0025F8	25	39	45	664	2100	0.10	195
E12	94SVPD226X0035E12	35	22	50	700	2300	0.12	154
	94SVPD476X0025E12	25	47	30	943	2980	0.12	235
F12	94SVPD476X0035F12	35	47	30	1150	3650	0.12	329
	94SVPD826X0025F12	25	82	28	1202	3800	0.12	410

Notes

(1) Capacitance tolerance: M ± 20 %

(2) After 2 minutes

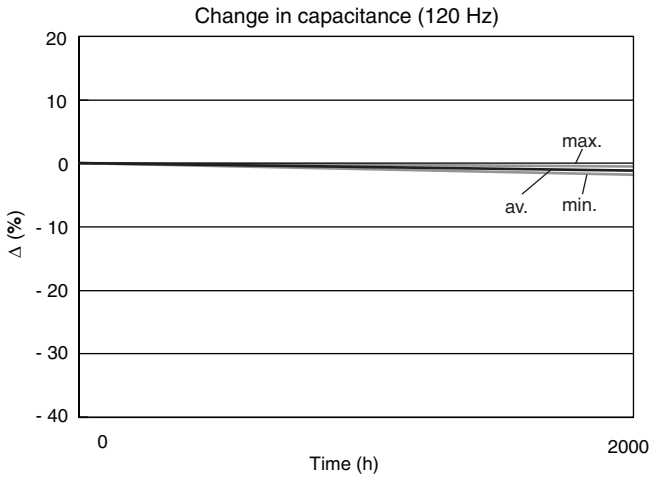
(3) Tx: Ambient temperature

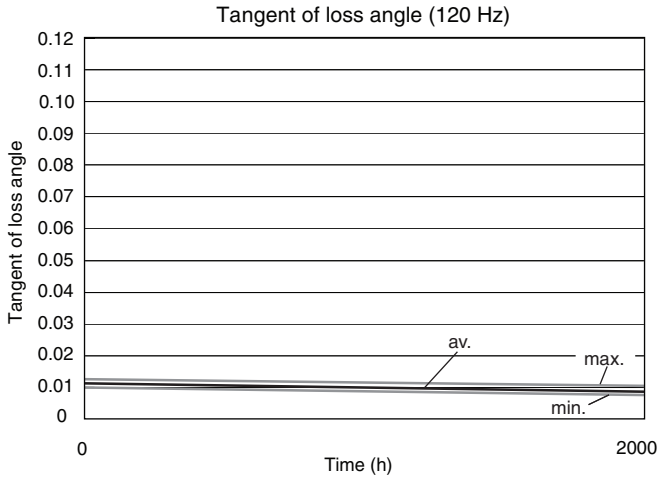


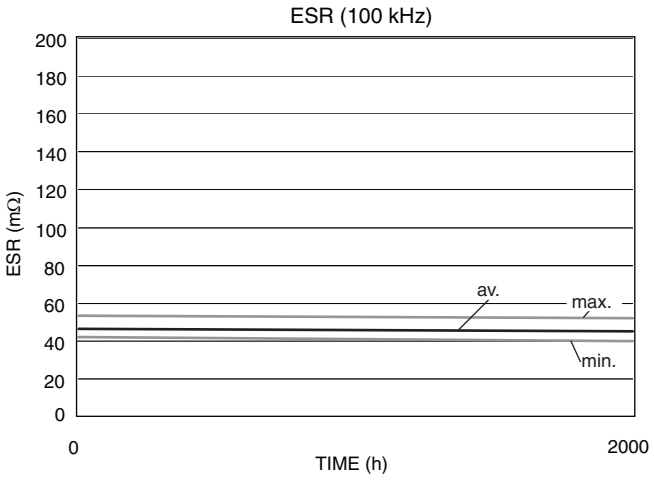
FREQUENCY (kHz)	0.12	0.5	1	10	100	500	1000	5000	10 000
94SVPD106X0025C6 IMPEDANCE (Ω)	127.769	31.001	15.608	1.612	0.176	0.046	0.032	0.093	0.179
94SVPD106X0025C6 ESR (Ω)	1.303	0.482	0.306	0.081	0.044	0.035	0.032	0.033	0.040
94SVPD186X0035F8 IMPEDANCE (Ω)	72.87	17.781	8.955	0.918	0.096	0.023	0.037	0.200	0.397
94SVPD186X0035F8 ESR (Ω)	1.681	0.333	0.179	0.043	0.027	0.023	0.023	0.026	0.034
94SVPD476X0035F12 IMPEDANCE (Ω)	30.178	7.389	3.725	0.392	0.05	0.016	0.025	0.134	0.266
94SVPD476X0035F12 ESR (Ω)	0.852	0.206	0.121	0.045	0.023	0.016	0.014	0.017	0.023
94SVPD826X0025F12 IMPEDANCE (Ω)	16.736	4.096	2.074	0.229	0.029	0.014	0.028	0.144	0.285
94SVPD826X0025F12 ESR (Ω)	0.339	0.135	0.094	0.033	0.015	0.011	0.011	0.014	0.019

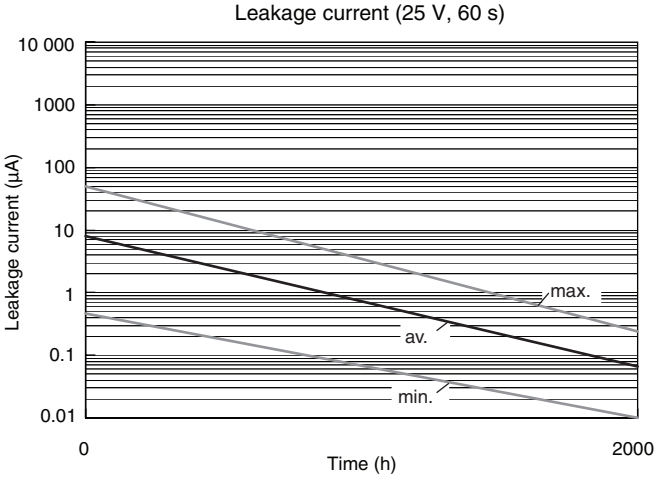
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	LOT. NUMBER
94SVPD106X0025C6	Endurance (after V.P.S. test)	125 °C	25 V	7130A2714









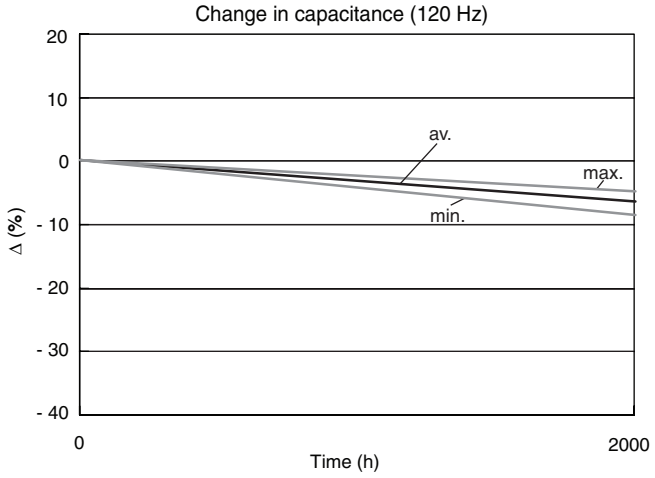
Notes

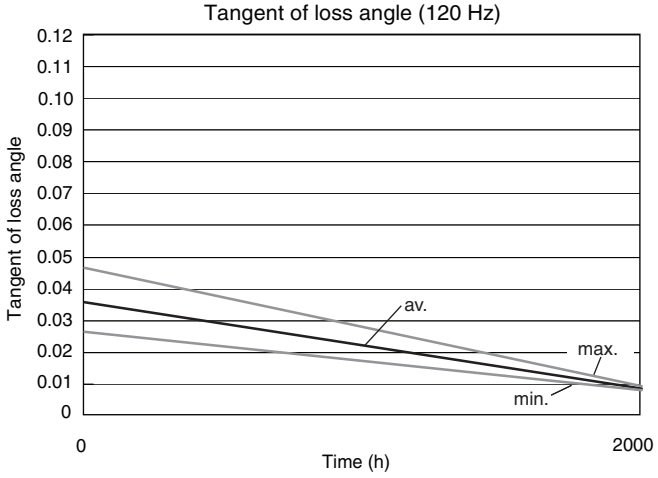
n = 30 pieces

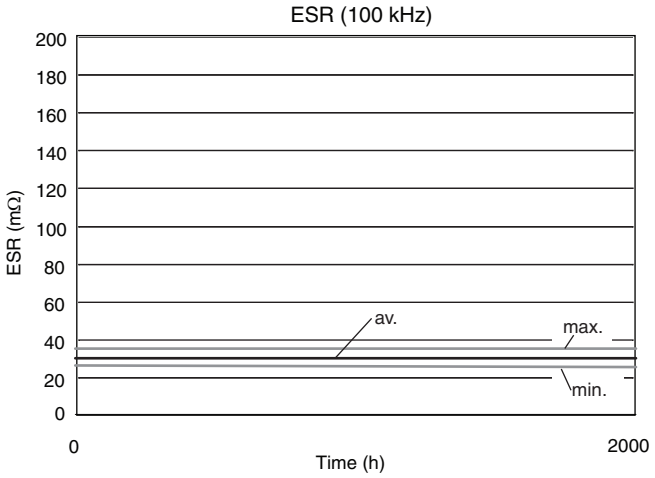
V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

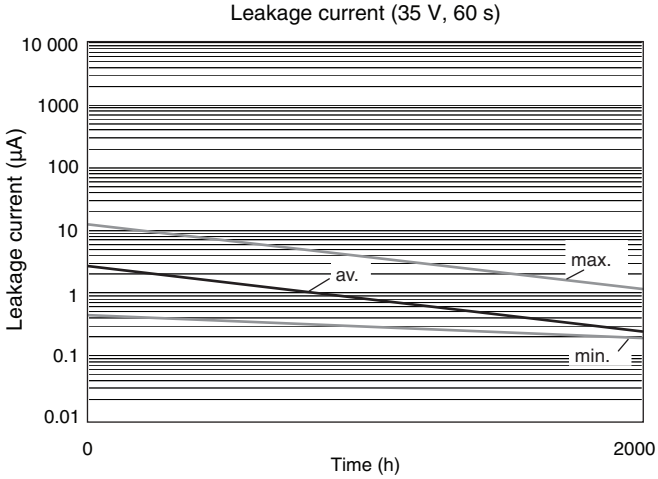
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	LOT. NUMBER
94SVPD186X0035F8	Endurance (after V.P.S. test)	125 °C	35 V	6517A3254









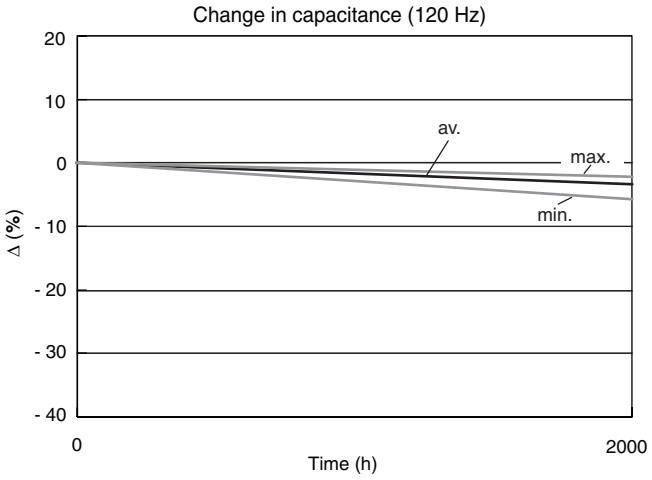
Notes

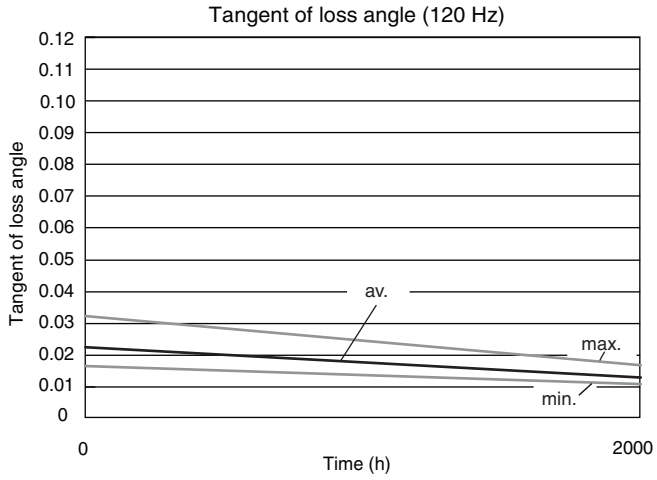
n = 30 pieces

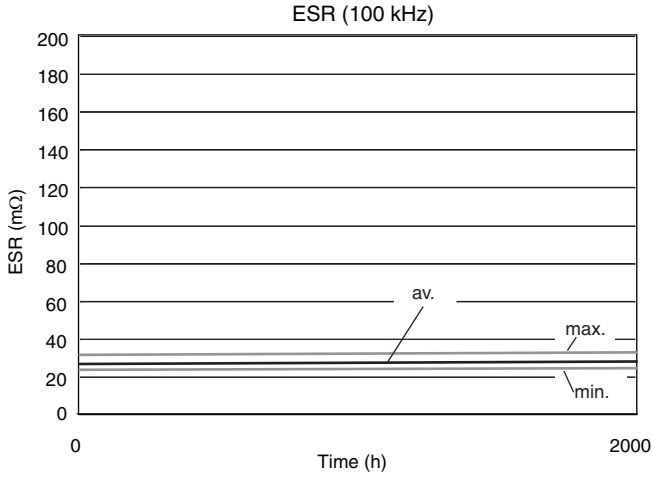
V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

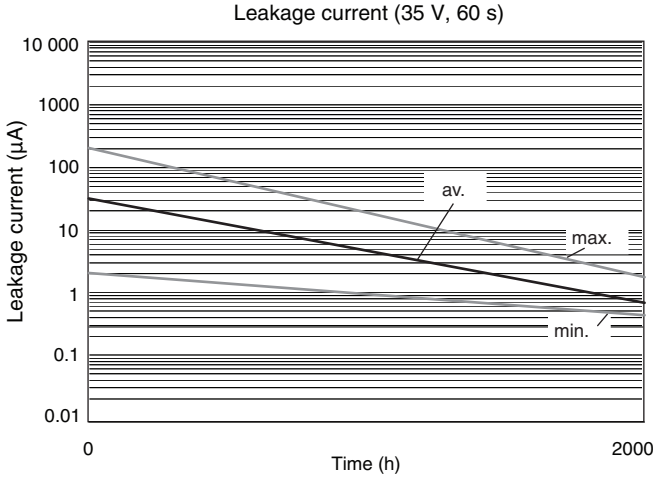
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	LOT. NUMBER
94SVPD476X0035F12	Endurance (after V.P.S. test)	125 °C	35 V	7209A6544









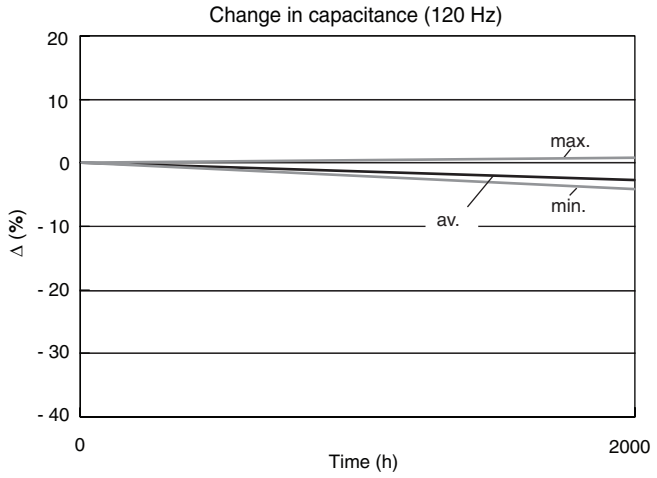
Notes

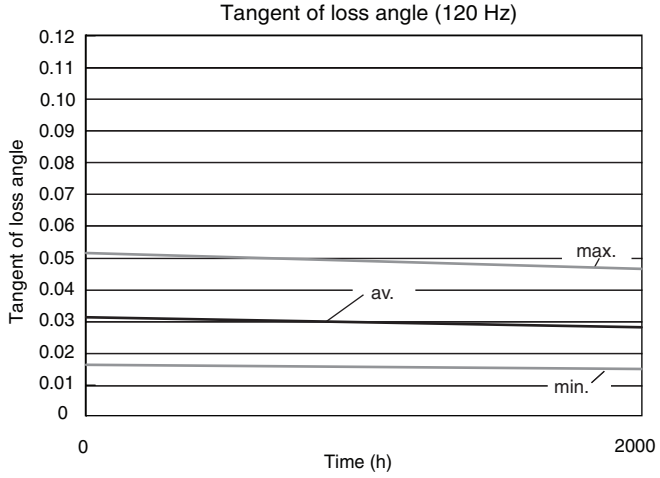
n = 30 pieces

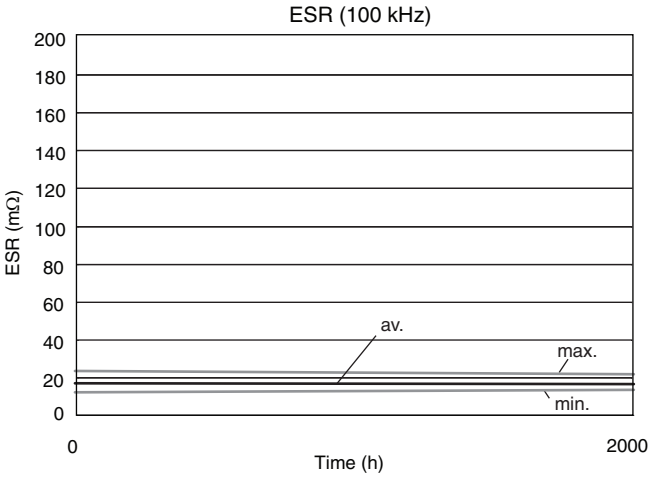
V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

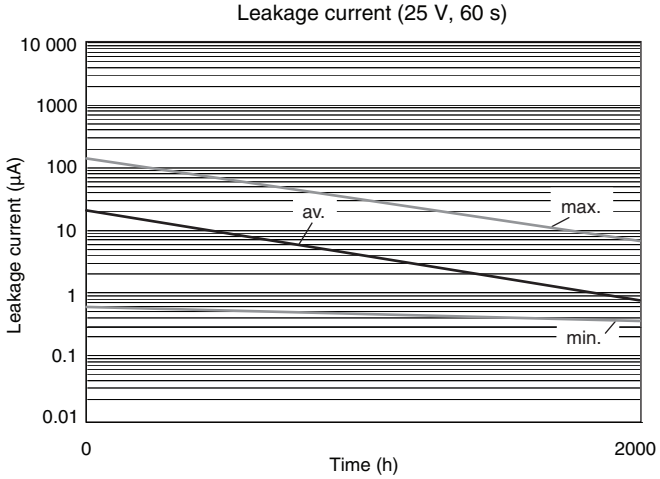
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	LOT. NUMBER
94SVPD826X0025F12	Endurance (after V.P.S. test)	125 °C	25 V	7527A6544









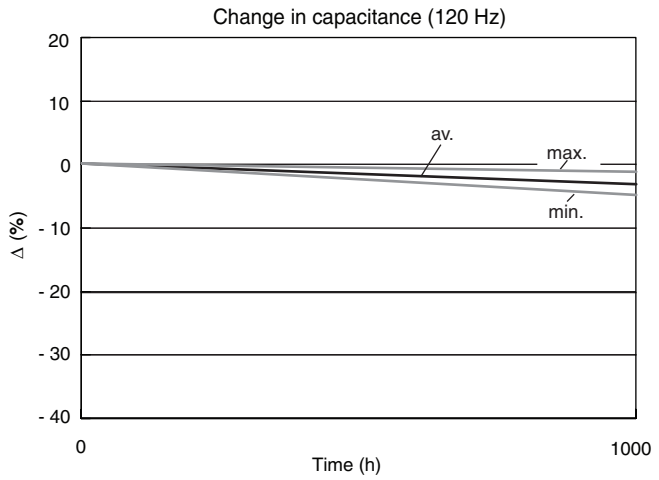
Notes

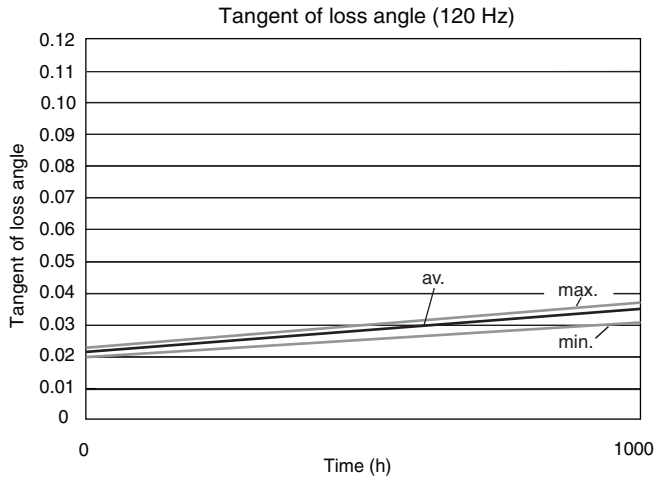
n = 30 pieces

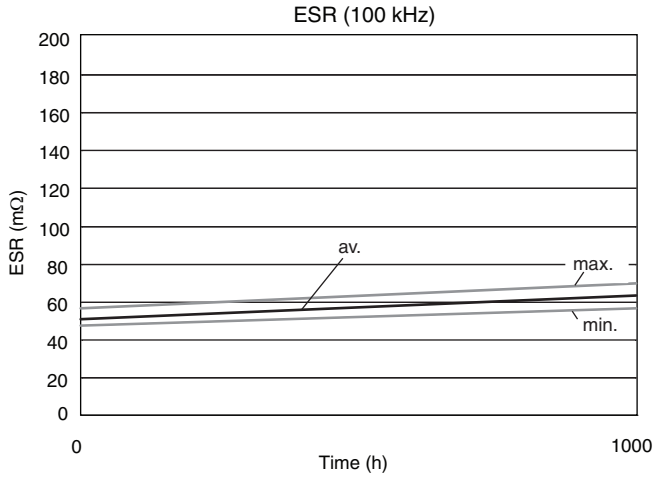
V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

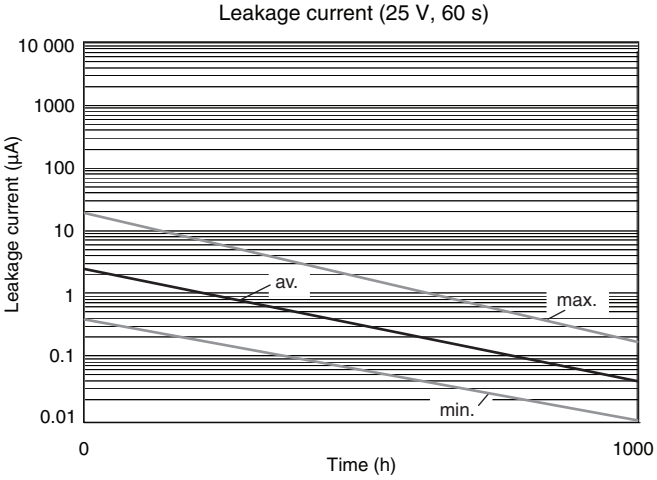
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	TEST HUMIDITY	LOT. NUMBER
94SVPD106X0025C6	Damp heat (steady state) (after V.P.S. test)	85 °C	25 V	85 %	7530A2714









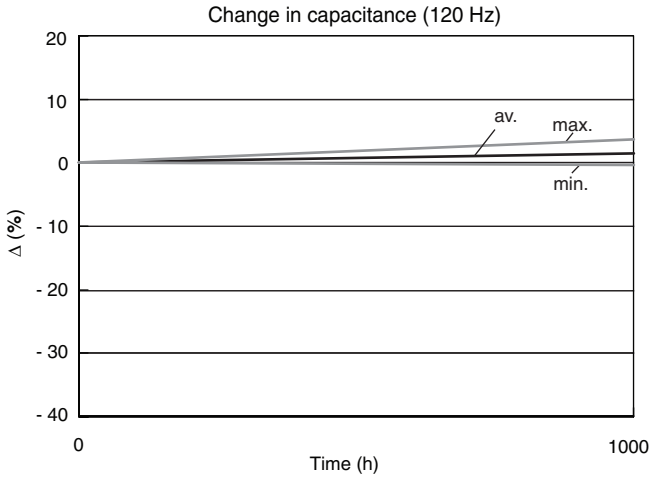
Notes

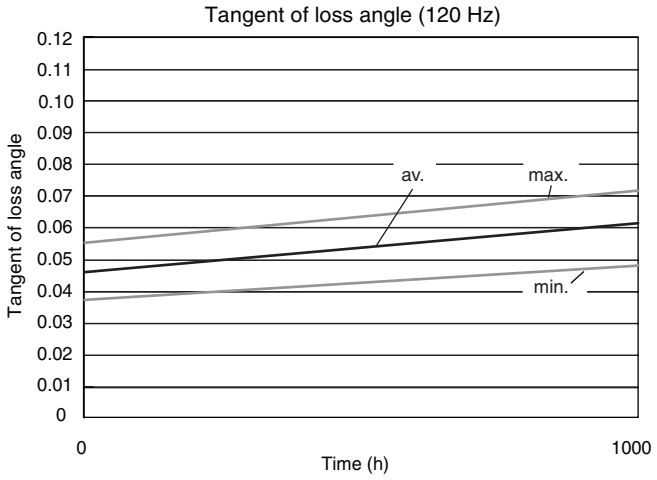
n = 30 pieces

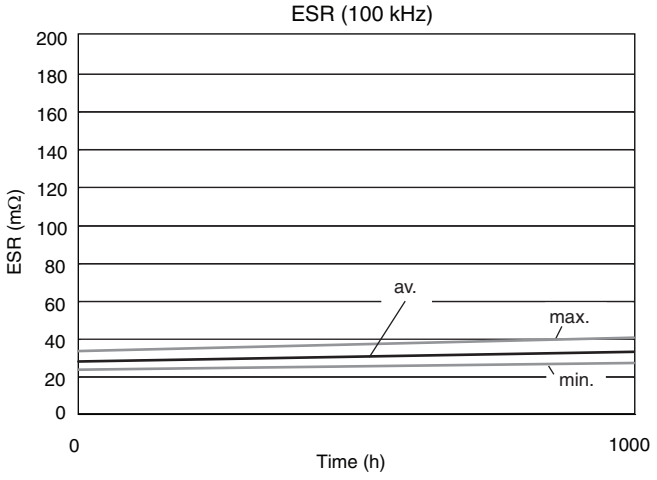
V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

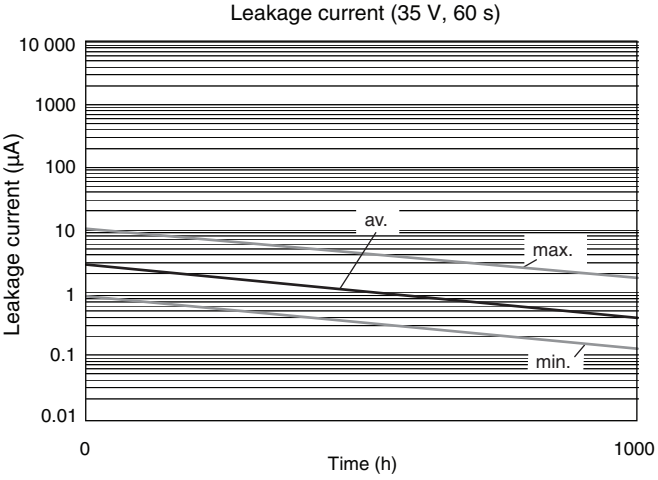
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	TEST HUMIDITY	LOT. NUMBER
94SVPD186X0035F8	Damp heat (steady state) (after V.P.S. test)	85 °C	35 V	85 %	6517A3254









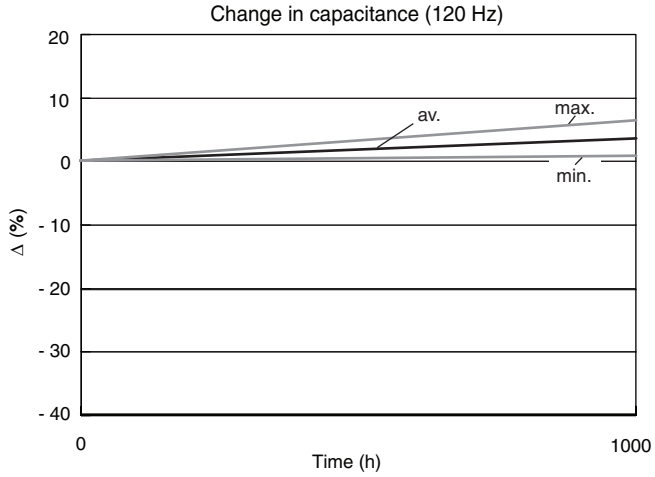
Notes

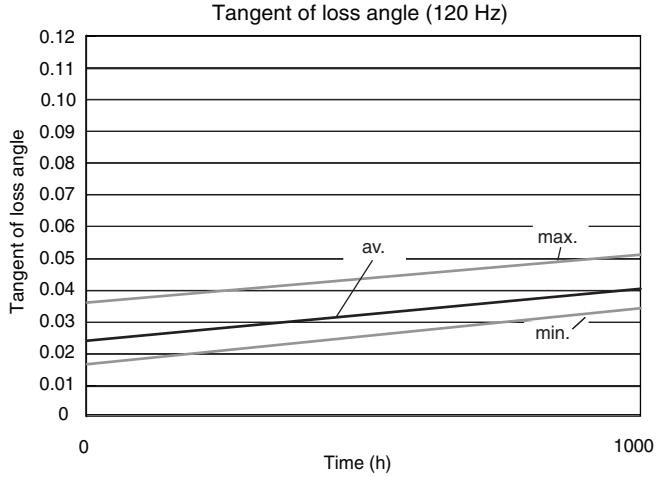
n = 30 pieces

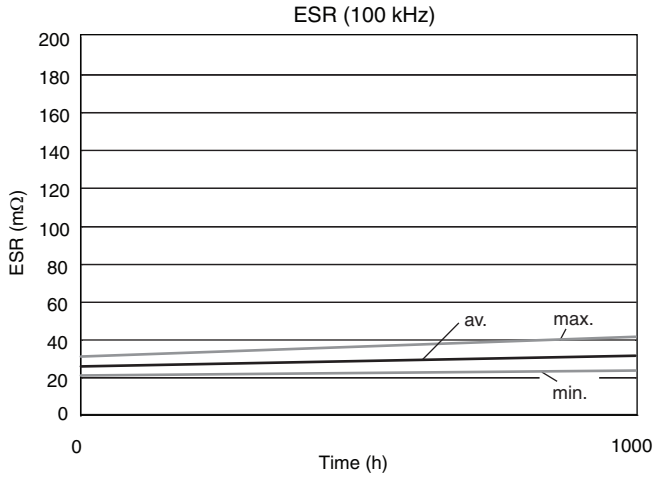
V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

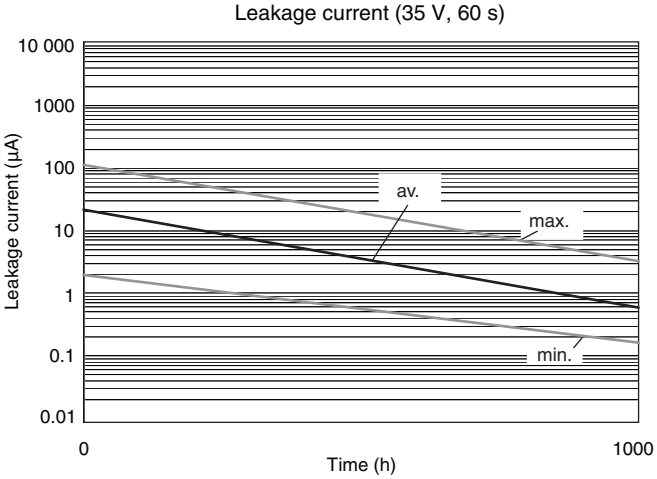
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	TEST HUMIDITY	LOT. NUMBER
94SVPD476X0035F12	Damp heat (steady state) (after V.P.S. test)	85 °C	35 V	85 %	7209A6544









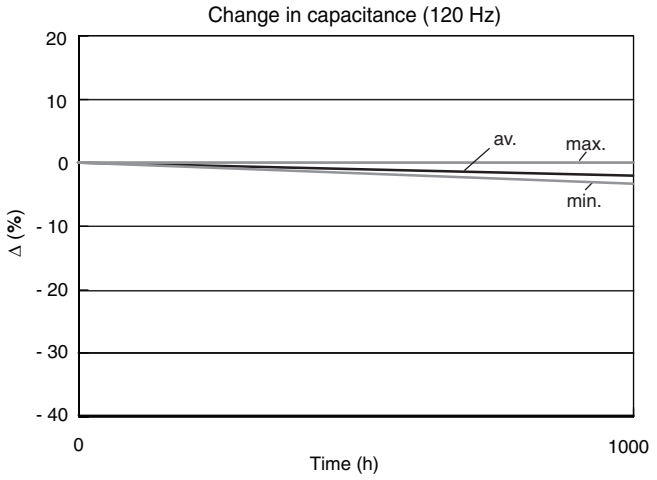
Notes

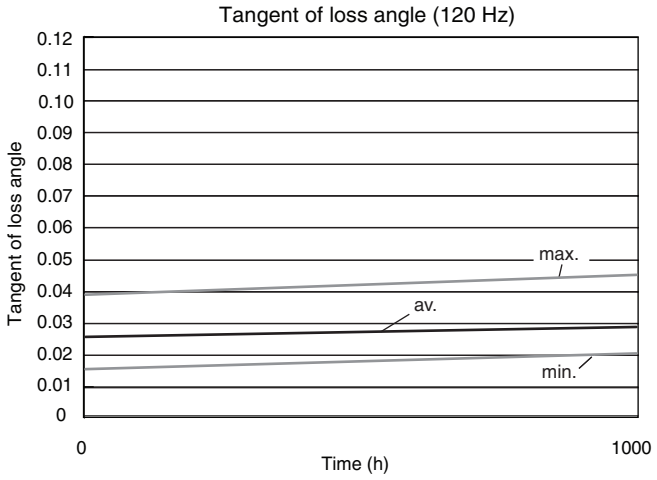
n = 30 pieces

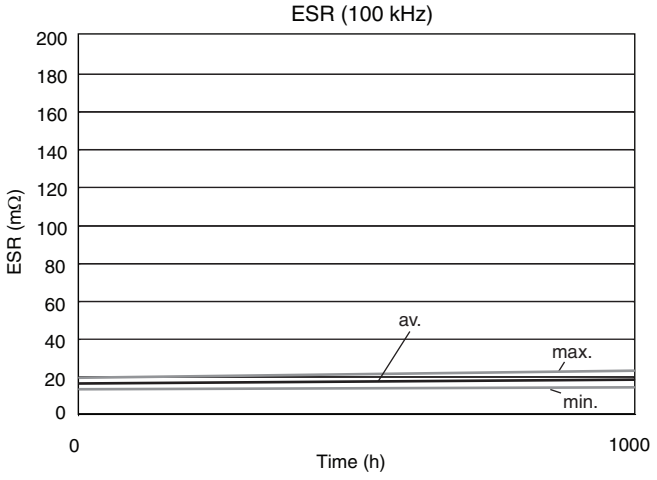
V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

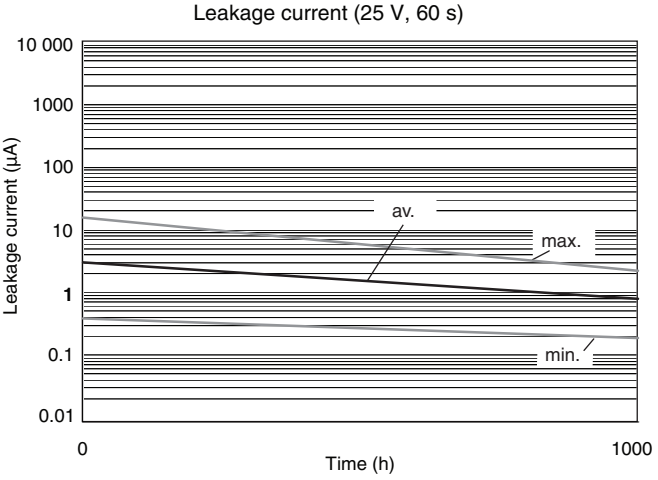
TYPICAL PARAMETERS

MODEL	TEST ITEM	TEST TEMPERATURE	APPLIED VOLTAGE	TEST HUMIDITY	LOT. NUMBER
94SVPD826X0025F12	Damp heat (steady state) (after V.P.S. test)	85 °C	25 V	85 %	6806A6724







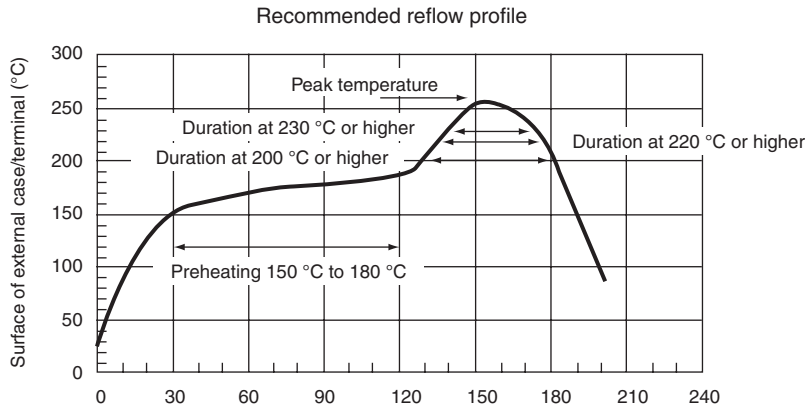


Notes

n = 30 pieces

V.P.S. test conditions: 230 °C x 75 s x 2 (V.P.S. = Vapor Phase Soldering method)

RECOMMENDED REFLOW PROFILE



Vishay OS-CON has different characteristics against soldering heat from conventional aluminum electrolytic capacitors or tantalum capacitors because of its unique materials and structure.

Please note the following points on soldering of Vishay OS-CON 94SVPD series to draw out the best performance.

ITEM	94SVPD SERIES	
Peak Temperature (max.)	250 °C	260 °C
Preheat	150 °C to 180 °C 90 ± 30 s	
200 °C over time (max.)	60 s	60 s
220 °C over time (max.)	50 s	50 s
230 °C over time (max.)	40 s	40 s
Reflow number	twice or less	only 1 time

Note

All temperatures are measured on the topside of the Al-can and terminal surface.

Attention:

Reflow soldering may reduce the capacitance of products before or after soldering even if soldering conditions stipulated in Recommended Reflow Condition are met. Though the actual reflow conditions are subject to change depending on the kind of reflow soldering method, please be aware that the peak temperature at the top of Al-case and electrode terminals should not exceed peak temperature. Particular notice should be given to the time that Vishay OS-CON is heated at 200 °C or higher during reflow. Be aware that soldering considerably deviating from these conditions will cause problems such as a 50 % reduction in capacitance, and a considerable increase in leakage current.

The leakage current value may increase (from a few uA to a few mA) even within the above conditions. When the Vishay OS-CON is used in a DC circuit, the leakage current will decrease gradually through self-recovery after voltage is applied. If your reflow profile (reflow temperature, number of reflows, etc. deviates from the above conditions for mounting the 94SVPD series, please consult with Vishay OS-CON.

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

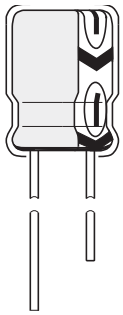


Fig.1 Component outline

FEATURES

- Designed for general use
- Superior high frequency characteristics
- 94SC capacitors are suitable for use in noise limiters and switching power supplies

Pb-free

RoHS COMPLIANT

PART MARKING

Sleeve color: Blue; Marking: White

- Polarity -
- Rated voltage
- Capacitance
- Vishay OS-CON
- Lot number
- Maximum operating temperature (+ 105 °C)

QUICK REFERENCE DATA			
DESCRIPTION	**VALUE**		
Operating temperature range	- 55 °C to + 105 °C		
Capacitance tolerance at 120 Hz	X0 = ± 20 %		
Tangent of loss angle (tan δ) at 120 Hz	≤ values in standard ratings table		
Leakage current (μA/2 minutes)(or less) (1)	6.3 to 25 WV: 0.01 CV or 0.5 30 WV: 0.0.2 CV or 0.1 (whichever is greater)		
Equivalent series resistance (Ω), (100 to 300 kHz)	≤ values in standard ratings table		
Temperature characteristics Impedance ratio at 100 kHz	- 55 °C	$Z/Z_{20\ °C}$	1.0 to 1.25
	+ 105 °C	$Z/Z_{20\ °C}$	0.75 to 1.0
High temperature load (+ 105 °C, 2000 hours) Rated voltage applied (25 WV - 20 V applied) (2)	ΔC/C	within ± 20 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of leakage current	
Moisture resistance (+ 60 °C, 90 to 95 % RH, 1000 hours, no voltage)	ΔC/C	within ± 10 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of leakage current	
Reverse voltage guarantee	temporary: ≤ 20 % of the rated voltage continuous: ≤ 10 % of the rated voltage		

Notes

(1) If any doubt arises, measure the current after applying voltage (voltage treatment) for 30 minutes at + 105 °C. The rated voltage should be applied for 6.3 to 16.3 WV, while temperature reduction voltage should be applied for 25 WV.

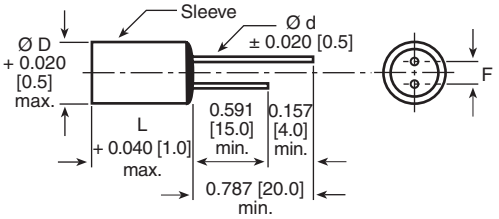
(2) To use a Vishay OS-CON capacitor when the operating temperature exceeds + 85 °C on a component with a rated voltage of 25 V, reduce the voltage by 0.25 V for every degree (1 °C) relative to the value at + 85 °C (25 V).

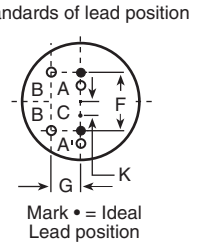
TEMPERATURE COEFFICIENT RIPPLE CURRENT	
AMBIENT TEMPERATURE	**COEFFICIENT**
~ + 45 °C	1.0
+ 85 °C	0.7
+ 95 °C	0.4
+ 105 °C	0.25

DIMENSIONS in inches [millimeters]					
CASE CODE	**NOMINAL CASE SIZE Ø D x L**	**F**	**Ø d**	**G (max.)**	**K (max.)**
A	0.157 x 0.268 [4.0 x 6.8]	0.079 [2.0]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
B	0.197 x 0.268 [5.0 x 6.8]	0.079 [2.0]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
C	0.248 x 0.268 [6.3 x 6.8]	0.098 [2.5]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
D	0.248 x 0.386 [6.3 x 9.8]	0.098 [2.5]	0.236 [0.60]	0.020 [0.5]	0.020 [0.5]
E	0.315 x 0.413 [8.0 x 10.5]	0.138 [3.5]	0.236 [0.60]	0.031 [0.8]	0.031 [0.8]
F	0.394 x 0.413 [10.0 x 10.5]	0.20 [5.0]	0.236 [0.60]	0.031 [0.8]	0.031 [0.8]

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

DIMENSIONS in inches [millimeters]





CASE CODE LIST						
WV (1)	(SV) (2)	6.3	10	16	25	30
CAPACITANCE (µF)		(7.3)	(11.5)	(18.4)	(25)	(34.5)
1.0		-	-	-	-	A
1.5		-	-	-	A	B
2.2		-	-	A	-	B
3.3		-	-	A	B	C
4.7		-	A	B	C	D
6.8		A	-	B	C	D
10.0		-	B	-	C	E
15.0		B	-	C	D	-
22.0		-	C	D	E	F
33.0		C	-	D	F	-
47.0		-	D	-	F	-

Notes

(1) WV = Rated Voltage.

(2) (SV) = Surge Voltage (at room temperature).

STANDARD RATINGS							
CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	MAX. ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 kHz to 300 kHz (mΩ)
A	94SC105X0030ABP	30.0	1.0	430	1.00	0.03	350
	94SC155X0025ABP	25.0	1.5	435	0.50	0.03	300
	94SC225X0016ABP	16.0	2.2	450	0.50	0.04	280
	94SC335X0016ABP	16.0	3.3	500	0.53	0.04	280
	94SC475X0010ABP	10.0	4.7	540	0.50	0.05	280
	94SC685X06R3ABP	6.3	6.8	560	0.50	0.05	250
B	94SC155X0030BBP	30.0	1.5	435	1.00	0.03	300
	94SC225X0030BBP	30.0	2.2	695	1.32	0.03	250
	94SC335X0025BBP	25.0	3.3	700	0.83	0.03	200
	94SC475X0016BBP	16.0	4.7	720	0.75	0.04	180
	94SC685X0016BBP	16.0	6.8	745	1.09	0.04	150
	94SC106X0010BBP	10.0	10.0	780	1.00	0.05	150
	94SC156X06R3BBP	6.3	15.0	815	0.95	0.05	120

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).

94SC106X0016...Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	MAX. ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 kHz to 300 kHz (mΩ)
C	94SC335X0030CBP	30.0	3.3	820	1.98	0.03	200
	94SC475X0025CBP	25.0	4.7	1130	1.18	0.03	100
	94SC685X0025CBP	25.0	6.8	1140	1.70	0.03	100
	94SC106X0025CBP	25.0	10.0	1150	2.50	0.03	90
	94SC156X0016CBP	16.0	15.0	1230	2.40	0.04	90
	94SC226X0010CBP	10.0	22.0	1270	2.20	0.05	70
	94SC336X06R3CBP	6.3	33.0	1320	2.08	0.05	70
D	94SC475X0030DBP	30.0	4.7	1300	2.82	0.04	120
	94SC685X0030DBP	30.0	6.8	1340	4.08	0.04	120
	94SC156X0025DBP	25.0	15.0	1650	3.75	0.04	70
	94SC226X0016DBP	16.0	22.0	1800	3.52	0.05	70
	94SC336X0016DBP	16.0	33.0	1900	5.28	0.06	70
	94SC476X0010DBP	10.0	47.0	2020	4.70	0.06	60
E	94SC106X0030EBP	30.0	10.0	1380	6.00	0.06	110
	94SC226X0025EBP	25.0	22.0	2330	5.50	0.06	40
F	94SC336X0025FBP	25.0	33.0	2900	8.25	0.06	35
	94SC476X0025FBP	25.0	47.0	2980	11.75	0.06	35
	94SC226X0030FBP	30.0	22.0	1830	13.20	0.06	80

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).

94SC106X0016...Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

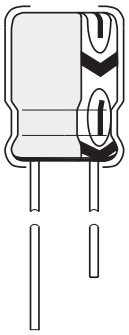


Fig.1 Component outline

FEATURES

- High capacitance
- Miniaturized
- 94SA capacitors are suitable for high frequency switching power supplies, etc

Pb-free
RoHS COMPLIANT

PART MARKING

Sleeve color: Blue; Marking: White

- Polarity -
- Rated voltage
- Capacitance
- Vishay OS-CON
- Lot number
- Maximum operating temperature (+ 105 °C)

QUICK REFERENCE DATA			
DESCRIPTION	**VALUE**		
Operating temperature range	- 55 °C to + 105 °C		
Capacitance tolerance at 120 Hz	X0 = ± 20 %		
Tangent of loss angle (tan δ) at 120 Hz	≤ values in standard ratings table		
Leakage current (μA/2 minutes)(or less) (1)	0.02 CV (0.04 CV for G, H size)		
Equivalent series resistance (Ω), (100 k to 300 kHz)	≤ values in standard ratings table		
Temperature characteristics at high temperature and low temperature Impedance ratio at 100 kHz	- 55 °C	$Z/Z_{20\ °C}$	1.0 to 1.25
	+ 105 °C	$Z/Z_{20\ °C}$	0.75 to 1.0
High temperature load (+ 105 °C, 2000 hours) (Ø D ≥ 12.5, 1000 hours) Rated voltage applied	ΔC/C	within ± 20 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of leakage current	
Moisture resistance (+ 60 °C, 90 to 95 % RH, 1000 hours, no voltage)	ΔC/C	within ± 10 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of leakage current	
Reverse voltage guarantee	temporary: < 20 % of the rated voltage continuous: < 10 % of the rated voltage		

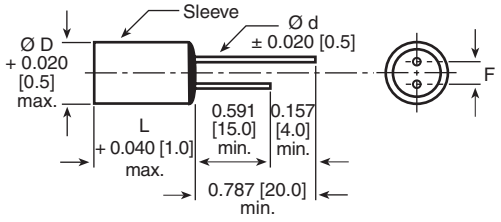
Note

(1) If any doubt arises, measure the current after applying voltage (voltage treatment) for 30 minutes at + 105 °C. The rated voltage should be for all WV.

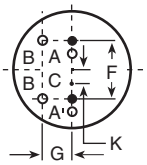
TEMPERATURE COEFFICIENT RIPPLE CURRENT	
AMBIENT TEMPERATURE	**COEFFICIENT**
~ + 45 °C	1.0
+ 85 °C	0.7
+ 95 °C	0.4
+ 105 °C	0.25

DIMENSIONS in inches [millimeters]					
CASE CODE	**NOMINAL CASE SIZE Ø D x L**	**F**	**Ø d**	**G (max.)**	**K (max.)**
C	0.248 x 0.268 [6.3 x 6.8]	0.098 ± 0.020 [2.5 ± 0.5]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
D	0.248 x 0.386 [6.3 x 9.8]	0.098 ± 0.020 [2.5 ± 0.5]	0.024 [0.60]	0.020 [0.5]	0.020 [0.5]
E	0.315 x 0.413 [8.0 x 10.5]	0.138 ± 0.020 [3.5 ± 0.5]	0.024 [0.60]	0.031 [0.8]	0.031 [0.8]
F	0.394 x 0.413 [10.0 x 10.5]	0.197 ± 0.020 [5.0 ± 0.5]	0.024 [0.60]	0.031 [0.8]	0.031 [0.8]
G	0.492 ± 0.866 [12.5 ± 22.0]	0.197 ± 0.040 [5.0 ± 1.0]	0.031 [0.80]	0.031 [0.8]	0.031 [0.8]
H	0.630 ± 0.984 [16.0 ± 25.0]	0.295 ± 0.040 [7.5 ± 1.0]	0.031 [0.80]	0.031 [0.8]	0.031 [0.8]

DIMENSIONS in inches [millimeters]



Standards of lead position



Mark • = Ideal
Lead position

C = The middle point of A - A'

CASE CODE LIST					
WV (1)	(SV) (2)	6.3	6.3	6.3	6.3
CAPACITANCE (µF)		(7.2)	(7.2)	(7.2)	(7.2)
15.0		-	-	-	-
22.0		-	-	-	-
33.0		-	-	-	-
47.0		C	C	C	C
68.0		-	-	-	-
100.0		-	-	-	-
150.0		E	E	E	E
220.0		-	-	-	-
330.0		F	F	F	F
470.0		-	-	-	-
1000.0		-	-	-	-
2200.0		H	H	H	H

Notes

(1) WV = Rated Voltage.

(2) (SV) = Surge Voltage (at room temperature).

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	MAX. ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 k to 300 kHz (mΩ)
C	94SA156X0020CBP	20.0	15.0	1200	6.00	0.06	90
	94SA226X0020CBP	20.0	22.0	1300	8.80	0.06	70
	94SA336X0016CBP	16.0	33.0	1370	10.56	0.06	70
	94SA476X06R3CBP	6.3	47.0	1430	5.92	0.07	60
D	94SA336X0020DBP	20.0	33.0	1710	13.20	0.06	70
	94SA476X0016DBP	16.0	47.0	1830	15.04	0.06	60
	94SA686X0010DBP	10.0	68.0	2000	13.60	0.07	50
E	94SA476X0020EBP	20.0	47.0	2450	18.80	0.06	40
	94SA686X0020EBP	20.0	68.0	2600	27.20	0.06	36
	94SA107X0016EBP	16.0	100.0	2740	32.00	0.06	30
	94SA157X06R3EBP	6.3	150.0	2780	18.90	0.07	30
F	94SA107X0020FBP	20.0	100.0	3210	40.00	0.06	30
	94SA157X0016FBP	16.0	150.0	3260	48.00	0.06	28
	94SA227X0010FBP	10.0	220.0	3370	44.00	0.07	27
	94SA337X06R3FBP	6.3	330.0	3500	41.58	0.07	25
G	94SA477X0016GBP	16.0	470.0	6080	300.80	0.08	20
H	94SA108X0016HBP	16.0	1000.0	9750	640.00	0.09	15
	94SA228X06R3HBP	6.3	2200.0	9750	554.40	0.13	15

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SA156X0020... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

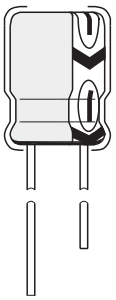


Fig.1 Component outline

FEATURES

- Super miniaturized (0.197" [5 mm] in height)
- Capacitors operate at + 105 °C
- 94SL capacitors are ideal for use in VCR's, car stereos and other products where a compact design is important

Pb-free
RoHS COMPLIANT

PART MARKING

Sleeve color: Blue. Marking: White

- Polarity -
- Rated voltage
- Capacitance
- Vishay OS-CON
- Lot number
- Maximum operating temperature (+ 105 °C)

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
Operating temperature range	- 55 °C to + 105 °C		
Capacitance tolerance at 120 Hz	X0 = ± 20 %		
Tangent of loss angle (tan δ) at 120 Hz	≤ values in standard ratings table		
Leakage current (μA/2 minutes)(or less) (1)	0.02 CV or 0.5 (whichever is greater)		
Equivalent series resistance (Ω), (100 to 300 kHz)	≤ values in standard ratings table		
Temperature characteristics Impedance ratio at 100 kHz	- 55 °C	$Z/Z_{20\ °C}$	1.0 to 1.25
	+ 105 °C	$Z/Z_{20\ °C}$	0.75 to 1.0
High temperature load (+ 105 °C, 2000 hours) Rated voltage applied (∅ D ≥ 8, 1000 hours) (25 WV - 20 V applied) (2)	ΔC/C	within ± 20 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of max. leakage current	
Moisture resistance (+ 60 °C, 90 to 95 % RH, 1000 hours, no voltage)	ΔC/C	within ± 20 % of the initial value	
	tan δ	≤ 2 x the value of tangent of loss angle	
	leakage current	≤ the value of max. leakage current	
Reverse voltage guarantee	temporary: < 20 % of the rated voltage continuous: < 10 % of the rated voltage		

Notes

(1) If any doubt arises, measure the current after applying voltage (voltage treatment) for 30 minutes at + 105 °C. The rated voltage should be applied for 4 to 16 WV, while temperature reduction voltage should be applied for 25 WV.

(2) To use a Vishay OS-CON capacitor when the operating temperature exceeds + 85 °C on a component with a rated voltage of 25 V, reduce the voltage by 0.25 V for every degree (1 °C) relative to the value at + 85 °C (25 V).

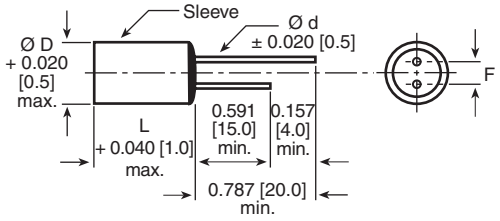
TEMPERATURE COEFFICIENT RIPPLE CURRENT

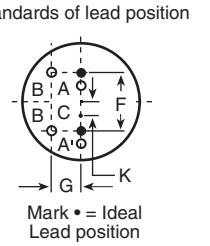
AMBIENT TEMPERATURE	COEFFICIENT
~ + 45 °C	1.0
+ 85 °C	0.7
+ 95 °C	0.4
+ 105 °C	0.25

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL CASE SIZE Ø D x L	F	Ø d	G (max.)	K (max.)
A'	0.158 x 0.197 [4.0 x 5.0]	0.059 [1.5]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
B'	0.197 x 0.197 [5.0 x 5.0]	0.079 [2.0]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
C'	0.248 x 0.197 [6.3 x 5.0]	0.098 [2.5]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
E'	0.315 x 0.197 [8.0 x 5.0]	0.138 [3.5]	0.020 [0.5]	0.031 [0.8]	0.031 [0.8]
F'	0.394 x 0.197 [10.0 x 5.0]	0.197 [5.0]	0.020 [0.5]	0.031 [0.8]	0.031 [0.8]

DIMENSIONS in inches [millimeters]





C = The middle point of A - A'

CASE CODE LIST						
WV (1)	(SV) (2)	4	6.3	10	16	25
CAPACITANCE (µF)		(4.6)	(7.2)	(11.5)	(18.4)	(25)
1.0		-	-	-	-	A’
1.5		-	-	-	-	A’
2.2		-	-	-	A’	B’
3.3		-	-	-	A’	B’
4.7		-	-	A’	B’	C’
6.8		-	A’	-	B’	C’
10.0		-	-	B’	C’	-
15.0		-	B’	-	C’	E’
22.0		-	-	C’	-	F’
33.0		-	-	C	-	-
47.0		-	-	C’	E’	-
68.0		-	-	E’	F’	-
100.0		-	E’	F’	-	-
150.0		E’	F’	-	-	-
220.0		F’	-	-	-	-

Notes

(1) WV = Rated Voltage.

(2) (SV) = Surge Voltage (at room temperature).

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	MAX. ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 to 300 kHz (mΩ)
A’	94SL105X0025ABP	25.0	1.0	430	0.50	0.05	450
	94SL155X0025ABP	25.0	1.5	435	0.75	0.05	400
	94SL225X0016ABP	16.0	2.2	450	0.70	0.05	400
	94SL335X0016ABP	16.0	3.3	500	1.06	0.06	400
	94SL475X0010ABP	10.0	4.7	540	0.94	0.06	400
	94SL685X06R3ABP	6.3	6.8	560	0.86	0.06	350
B’	94SL225X0025BBP	25.0	2.2	695	1.10	0.05	250
	94SL335X0025BBP	25.0	3.3	700	1.65	0.05	250
	94SL475X0016BBP	16.0	4.7	720	1.50	0.05	250
	94SL685X0016BBP	16.0	6.8	745	2.18	0.05	180
	94SL106X0010BBP	10.0	10.0	780	2.00	0.05	150
	94SL156X06R3BBP	6.3	15.0	815	1.89	0.06	120

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SL106X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	MAX. ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 to 300 kHz (mΩ)
C'	94SL475X0025CBP	25.0	4.7	1130	2.35	0.06	100
	94SL685X0025CBP	25.0	6.8	1140	3.40	0.06	100
	94SL106X0016CBP	16.0	10.0	1150	3.20	0.06	100
	94SL156X0016CBP	16.0	15.0	1230	4.80	0.06	100
	94SL226X0010CBP	10.0	22.0	1270	4.40	0.06	80
	94SL336X0010CBP	10.0	33.0	1350	6.60	0.06	80
	94SL476X0010CBP	10.0	47.0	1430	9.40	0.06	70
E'	94SL156X0025EBP	25.0	15.0	1400	7.50	0.07	75
	94SL476X0016EBP	16.0	47.0	1550	15.04	0.07	70
	94SL686X0010EBP	10.0	68.0	1600	13.60	0.07	65
	94SL107X06R3EBP	6.3	100.0	1600	12.60	0.07	65
	94SL157X0004EBP	4.0	150.0	2000	12.00	0.07	60
F'	94SL226X0025FBP	25.0	22.0	1600	11.00	0.07	70
	94SL686X0016FBP	16.0	68.0	1850	21.76	0.07	65
	94SL107X0010FBP	10.0	100.0	2100	20.00	0.07	60
	94SL157X06R3FBP	6.3	150.0	2100	18.90	0.07	60
	94SL227X0004FBP	4.0	220.0	2400	17.60	0.07	55

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SL106X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

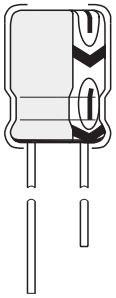


Fig.1 Component outline

FEATURES

- Guaranteed long life (+ 105 °C x 5000 hours)
- 94SH capacitors are used for industrial equipment

Pb-free

RoHS COMPLIANT

PART MARKING

Sleeve color: Blue; Marking: White

- Polarity -
- Rated voltage
- Capacitance
- Vishay OS-CON
- Lot number
- Type
- Maximum operating temperature (+ 105 °C)

QUICK REFERENCE DATA			
DESCRIPTION	**VALUE**		
Operating temperature range	- 55 °C to + 105 °C		
Capacitance tolerance at 120 Hz	X0 = ± 20 %		
Tangent of loss angle (tan δ) at 120 Hz	≤ values in standard ratings table		
Leakage current (μA/2 minutes)(or less)[1]	0.02 CV or 0.5 (whichever is greater)		
Equivalent series resistance (Ω), (100 to 300 kHz)	≤ values in standard ratings table		
Temperature characteristics Impedance ratio at 100 kHz	- 55 °C	$Z/Z_{20\ °C}$	1.0 to 1.25
	+ 105 °C	$Z/Z_{20\ °C}$	0.75 to 1.0
High temperature load (+ 105 °C, 5000 hours) Rated voltage applied (25 WV - 20 V)[2]	ΔC/C	within ± 30 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ 5 x the value of leakage current	
Moisture resistance (+ 60 °C, 90 to 95 % RH, 1000 hours, no voltage)	ΔC/C	within ± 10 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of leakage current	
Reverse voltage guarantee	temporary: ≤ 20 % of the rated voltage continuous: ≤ 10 % of the rated voltage		

Notes

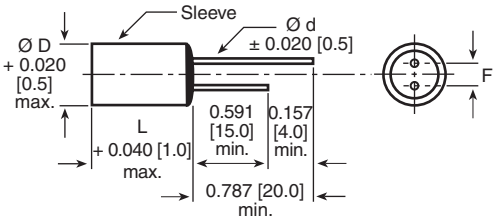
(1) If any doubt arises, measure the current after applying voltage (voltage treatment) for 30 minutes at + 105 °C. The rated voltage should be applied for 4 to 16 WV, while temperature reduction voltage should be applied for 25 WV.

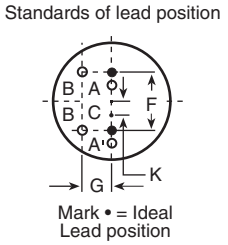
(2) To use a Vishay OS-CON capacitor when the operating temperature exceeds + 85 °C on a component with a rated voltage of 25 V, reduce the voltage by 0.25 V for every degree (1 °C) relative to the value at + 85 °C (25 V).

TEMPERATURE COEFFICIENT RIPPLE CURRENT	
AMBIENT TEMPERATURE	**COEFFICIENT**
~ + 45 °C	1.0
+ 85 °C	0.7
+ 95 °C	0.4
+ 105 °C	0.25

DIMENSIONS in inches [millimeters]					
CASE CODE	**NOMINAL CASE SIZE Ø D x L**	**F**	**Ø d**	**G (max.)**	**K (max.)**
A	0.158 x 0.268 [4.0 x 6.8]	0.079 [2.0]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
B	0.197 x 0.268 [5.0 x 6.8]	0.079 [2.0]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
C	0.248 x 0.268 [6.3 x 6.8]	0.098 [2.5]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
D	0.248 x 0.386 [6.3 x 9.8]	0.098 [2.5]	0.024 [0.6]	0.020 [0.5]	0.020 [0.5]
E	0.315 x 0.413 [8.0 x 10.5]	0.138 [3.5]	0.024 [0.6]	0.031 [0.8]	0.031 [0.8]
F	0.394 x 0.413 [10.0 x 10.5]	0.020 [5.0]	0.024 [0.6]	0.031 [0.8]	0.031 [0.8]

DIMENSIONS in inches [millimeters]





C = The middle point of A - A'

CASE CODE LIST						
WV (1)	(SV) (1)	6.3	10	16	20	25
CAPACITANCE (µF)		(7.2)	(11.5)	(18.4)	(23)	(25)
1.0		-	-	A	-	A
1.5		-	-	-	-	A
2.2		-	-	A	-	B
3.3		-	-	A	-	B
4.7		-	A	B	-	C
6.8		A	-	B	-	C
10.0		-	B	C	-	C
15.0		B	-	-	C	D
22.0		-	-	-	C	-
33.0		-	-	C	D	-
47.0		C	-	D	E	-
68.0		-	D	-	E	-
100.0		-	-	E	F	-
150.0		E	-	F	-	-
220.0		-	F	-	-	-
330.0		F	-	-	-	-

Notes

(1) WV = Rated Voltage.

(2) (SV) = Surge Voltage (at room temperature).

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 to 300 kHz (mΩ)
A	94SH105X0025ABP	25.0	1.0	430	0.50	0.03	350
	94SH155X0025ABP	25.0	1.5	435	0.75	0.03	300
	94SH105X0016ABP	16.0	1.0	430	0.50	0.03	350
	94SH225X0016ABP	16.0	2.2	450	0.70	0.04	280
	94SH335X0016ABP	16.0	3.3	500	1.06	0.04	280
	94SH475X0010ABP	10.0	4.7	540	0.94	0.05	280
	94SH685X06R3ABP	6.3	6.8	560	0.86	0.05	250
B	94SH225X0025BBP	25.0	2.2	695	1.10	0.03	200
	94SH335X0025BBP	25.0	3.3	700	1.65	0.03	200
	94SH475X0016BBP	16.0	4.7	720	1.50	0.04	180
	94SH685X0016BBP	16.0	6.8	745	2.18	0.04	150
	94SH106X0010BBP	10.0	10.0	780	2.00	0.05	150
	94SH156X06R3BBP	6.3	15.0	815	1.89	0.05	120

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SH106X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 to 300 kHz (mΩ)
C	94SH475X0025CBP	25.0	4.7	1130	2.35	0.03	100
	94SH685X0025CBP	25.0	6.8	1140	3.40	0.03	100
	94SH106X0025CBP	25.0	10.0	1150	5.00	0.03	90
	94SH156X0020CBP	20.0	15.0	1200	6.00	0.05	90
	94SH226X0020CBP	20.0	22.0	1300	8.80	0.05	70
	94SH106X0016CBP	16.0	10.0	1150	3.20	0.04	90
	94SH336X0016CBP	16.0	33.0	1370	10.56	0.06	70
	94SH476X06R3CBP	6.3	47.0	1430	5.92	0.07	60
D	94SH156X0025DBP	25.0	15.0	1650	7.50	0.04	70
	94SH336X0020DBP	20.0	33.0	1710	13.20	0.06	70
	94SH476X0016DBP	16.0	47.0	1830	15.04	0.06	60
	94SH686X0010DBP	10.0	68.0	2000	13.60	0.07	50
E	94SH476X0020EBP	20.0	47.0	2450	18.80	0.06	40
	94SH686X0020EBP	20.0	68.0	2600	27.20	0.06	36
	94SH107X0016EBP	16.0	100.0	2740	32.00	0.06	30
	94SH157X06R3EBP	6.3	150.0	2780	18.90	0.07	30
F	94SH107X0020FBP	20.0	100.0	3210	40.00	0.06	30
	94SH157X0016FBP	16.0	150.0	3260	48.00	0.06	28
	94SH227X0010FBP	10.0	220.0	3370	44.00	0.07	27
	94SH337X06R3FBP	6.3	330.0	3500	41.58	0.07	25

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SH106X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

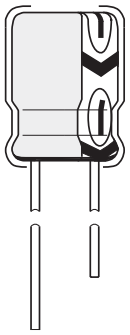


Fig.1 Component outline

FEATURES

- Miniaturized version of Types 94SA, 94SC, 94SL
- 94SS capacitors are used where a compact design is needed for switching supplies, etc.

Pb-free
RoHS COMPLIANT

PART MARKING

Sleeve color: Blue; Marking: White

- Polarity -
- Rated voltage
- Capacitance
- OS-CON
- Lot number
- Type
- Maximum operating temperature (+ 105 °C)

QUICK REFERENCE DATA			
DESCRIPTION	**VALUE**		
Operating temperature range	- 55 °C ~ + 105 °C		
Capacitance tolerance at 120 Hz	X0 = ± 20 %		
Tangent of loss angle (tan δ) at 120 Hz	≤ values in standard ratings table		
Maximum leakage current (μA/2 minutes) (1)	0.05 CV		
Equivalent series resistance (Ω), (100 ~ 300 kHz)	≤ values in standard ratings table		
Temperature characteristics Impedance ratio at 100 kHz	- 55 °C	$Z/Z_{20\ °C}$	1.0 ~ 1.25
	+ 105 °C	$Z/Z_{20\ °C}$	0.75 ~ 1.0
High temperature load (+ 105 °C, 1000 hours) Rated voltage applied	Δ C/C	within ± 20 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of max. leakage current	
Moisture resistance (+ 60 °C, 90 ~ 95 % RH, 1000 hours, no voltage)	Δ C/C	within ± 20 % of the initial value	
	tan δ	≤ 2 x the value of tangent of loss angle	
	leakage current	≤ the value of max. leakage current	
Reverse voltage guarantee	temporary: less than 20 % of the rated voltage continuous: less than 10 % of the rated voltage		

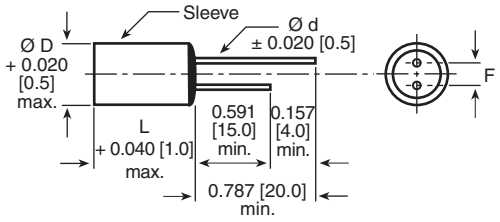
Note

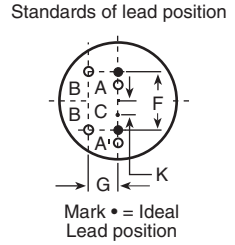
(1) If any doubt arises, measure the current after applying voltage (voltage treatment) for 30 minutes at + 105 °C. The rated voltage should be applied for all WV.

TEMPERATURE COEFFICIENT RIPPLE CURRENT	
AMBIENT TEMPERATURE	**COEFFICIENT**
~ + 45 °C	1.0
+ 85 °C	0.7
+ 95 °C	0.4
+ 105 °C	0.25

DIMENSIONS in inches [millimeters]					
CASE CODE	**NOMINAL CASE SIZE Ø D x L**	**F**	**Ø d**	**G (max.)**	**K (max.)**
A'	0.158 x 0.197 [4.0 x 5.0]	0.059 [1.5]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
B'	0.197 x 0.197 [5.0 x 5.0]	0.079 [2.0]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
C'	0.248 x 0.197 [6.3 x 5.0]	0.098 [2.5]	0.018 [0.45]	0.020 [0.5]	0.020 [0.5]
D	0.248 x 0.386 [6.3 x 9.8]	0.098 [2.5]	0.234 [0.6]	0.020 [0.5]	0.020 [0.5]
E	0.315 x 0.413 [8.0 x 10.5]	0.138 [3.5]	0.234 [0.6]	0.031 [0.8]	0.031 [0.8]
F	0.394 x 0.413 [10.0 x 10.5]	0.197 [5.0]	0.234 [0.6]	0.031 [0.8]	0.031 [0.8]

DIMENSIONS in inches [millimeters]





C = The middle point of A - A'

CASE CODE LIST						
WV (1)	(SV) (2)	4	6.3	10	16	20
CAPACITANCE (µF)		(4.6)	(7.2)	(11.5)	(18.4)	(23)
2.2		-	-	-	-	A’
3.3		-	-	-	-	A’
4.7		-	-	-	A’	B’
6.8		-	-	-	A’	B’
10.0		-	-	A’	B’	C’
15.0		-	A’	-	B’	C’
22.0		-	-	B’	-	C’
33.0		-	B’	-	C’	-
47.0		-	-	-	-	D
68.0		C’	-	-	D	-
100.0		-	-	D	-	E
150.0		D	-	E	-	F
220.0		-	E	-	-	-
330.0		-	-	F	-	-
470.0		F	-	-	-	-

Notes

(1) WV = Rated Voltage.

(2) (SV) = Surge Voltage (at room temperature).

STANDARD RATINGS in inches [millimeters]							
CASE CODE	PART NUMBER*	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	MAX. ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 ~ 300 kHz (mΩ)
A’	94SS225X0020ABP	20.0	2.2	450	2.20	0.05	400
	94SS335X0020ABP	20.0	3.3	500	3.30	0.06	400
	94SS475X0016ABP	16.0	4.7	540	3.76	0.06	400
	94SS685X0016ABP	16.0	6.8	540	5.44	0.06	400
	94SS106X0010ABP	10.0	10.0	560	5.00	0.06	350
	94SS156X06R3ABP	6.3	15.0	560	4.73	0.06	350
B’	94SS475X0020BBP	20.0	4.7	720	4.70	0.05	250
	94SS685X0020BBP	20.0	6.8	745	6.80	0.05	180
	94SS106X0016BBP	16.0	10.0	780	8.00	0.05	150
	94SS156X0016BBP	16.0	15.0	780	12.00	0.05	150
	94SS226X0010BBP	10.0	22.0	780	11.00	0.05	150
	94SS336X06R3BBP	6.3	33.0	780	10.40	0.05	150

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SS106X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

STANDARD RATINGS in inches [millimeters]							
CASE CODE	**PART NUMBER***	**RATED VOLTAGE (V)**	**NOMINAL CAPACITANCE (µF)**	**MAX. ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C**	**MAX. LEAKAGE CURRENT (µA) (after 2 min)**	**MAX. TANGENT OF LOSS ANGLE**	**MAX. ESR 100 ~ 300 kHz (mΩ)**
C'	94SS106X0020CBP	20.0	10.0	1150	10.00	0.06	100
	94SS156X0020CBP	20.0	15.0	1230	15.00	0.06	100
	94SS226X0020CBP	20.0	22.0	1230	22.00	0.06	100
	94SS336X0016CBP	16.0	33.0	1230	26.40	0.06	100
	94SS686X0004CBP	4.0	68.0	1430	13.60	0.06	70
D	94SS476X0020DBP	20.0	47.0	1830	47.00	0.06	60
	94SS686X0016DBP	16.0	68.0	2000	54.40	0.07	50
	94SS107X0010DBP	10.0	100.0	2100	50.00	0.07	40
	94SS157X0004DBP	4.0	150.0	2100	30.00	0.08	40
E	94SS107X0020EBP	20.0	100.0	2740	100.00	0.07	30
	94SS157X0010EBP	10.0	150.0	2780	75.00	0.07	30
	94SS227X06R3EBP	6.3	220.0	3000	69.30	0.07	30
F	94SS157X0020FBP	20.0	150.0	3200	150.00	0.07	30
	94SS337X0010FBP	10.0	330.0	3500	165.00	0.07	25
	94SS477X0004FBP	4.0	470.0	3500	94.00	0.07	25

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SS106X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

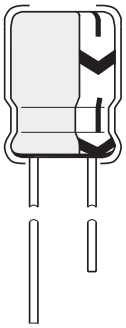


Fig.1 Component outline

FEATURES

- High capacity, low ESR. Approximately two times the capacitance of existing capacitors and less than half the ESR
- 94SP capacitors are ideal for designing around MPU's for computer equipment

Pb-free

RoHS COMPLIANT

PART MARKING

Sleeve color: Blue; Marking: White

- Polarity -
- Rated voltage
- Capacitance
- Vishay OS-CON
- Lot number
- Type
- Maximum operating temperature (+ 105 °C)

QUICK REFERENCE DATA			
DESCRIPTION	**VALUE**		
Operating temperature range	- 55 °C to + 105 °C		
Capacitance tolerance at 120 Hz	X0 = ± 20 %		
Tangent of loss angle (tan δ) at 120 Hz	≤ values in standard ratings table		
Maximum leakage current (μA/2 minutes)(or less) (1)	0.1 CV		
Equivalent series resistance (Ω), (100 to 300 kHz)	≤ values in standard ratings table		
Temperature characteristics Impedance ratio at 100 kHz	- 55 °C	$Z/Z_{20\ °C}$	1.0 to 1.25
	+ 105 °C	$Z/Z_{20\ °C}$	0.75 to 1.0
High temperature load (+ 105 °C, 1000 hours) Rated voltage applied	ΔC/C	within ± 20 % of the initial value	
	tan δ	≤ 1.5 x the value of tangent of loss angle	
	leakage current	≤ the value of max. leakage current	
Moisture resistance (+ 60 °C, 90 to 95 % RH, 1000 hours, no voltage)	ΔC/C	within ± 20 % of the initial value	
	tan δ	≤ 2 x the value of tangent of loss angle	
	leakage current	≤ the value of max. leakage current	
Reverse voltage guarantee	temporary: < 20 % of the rated voltage continuous: < 10 % of the rated voltage		

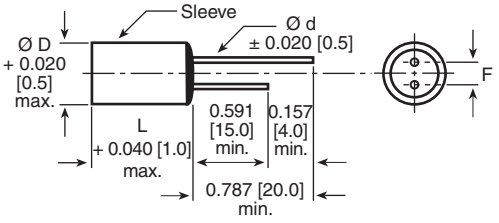
Note

(1) If any doubt arises, measure the current after applying voltage (voltage treatment) for 30 minutes at + 105 °C. The rated voltage should be applied for all WV.

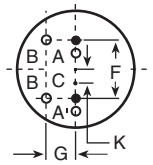
TEMPERATURE COEFFICIENT RIPPLE CURRENT	
AMBIENT TEMPERATURE	**COEFFICIENT**
~ + 45 °C	1.0
+ 85 °C	0.7
+ 95 °C	0.4
+ 105 °C	0.25

DIMENSIONS in inches [millimeters]					
CASE CODE	**NOMINAL CASE SIZE Ø D x L**	**F**	**Ø d**	**G (max.)**	**K (max.)**
C'	0.248 x 0.197 [6.3 x 5.0]	0.098 ± 0.020 [2.5 ± 0.5]	0.024 [0.6]	0.020 [0.5]	0.020 [0.5]
E'	0.315 x 0.197 [8.0 x 5.0]	0.138 ± 0.020 [3.5 ± 0.5]	0.024 [0.6]	0.031 [0.8]	0.031 [0.8]
F'	0.394 x 0.197 [10.0 x 5.0]	0.197 ± 0.020 [5.0 ± 0.5]	0.024 [0.6]	0.031 [0.8]	0.031 [0.8]
C	0.248 x 0.268 [6.3 x 6.8]	0.098 ± 0.020 [2.5 ± 0.5]	0.024 [0.6]	0.020 [0.5]	0.020 [0.5]
E	0.315 x 0.413 [8.0 x 10.5]	0.138 ± 0.020 [3.5 ± 0.5]	0.024 [0.6]	0.031 [0.8]	0.031 [0.8]
F	0.394 x 0.413 [10.0 x 10.5]	0.197 ± 0.020 [5.0 ± 0.5]	0.024 [0.6]	0.031 [0.8]	0.031 [0.8]
F_0	0.394 x 0.787 [10.0 x 20.0]	0.197 ± 0.020 [5.0 ± 0.5]	0.031 [0.8]	0.031 [0.8]	0.031 [0.8]
G	0.492 x 0.866 [12.5 x 22.0]	0.197 ± 0.040 [5.0 ± 1.0]	0.031 [0.8]	0.031 [0.8]	0.031 [0.8]

DIMENSIONS in inches [millimeters]



Standards of lead position



Mark • = Ideal
Lead position

C = The middle point of A - A'

CASE CODE LIST

WV (1) / SV (2)	4	6.3	10	16	20
CAPACITANCE (µF)	5.2	8.2	11.5	18.4	23
22.0	-	-	-	-	C'
33.0	-	-	-	C'	C
47.0	-	-	-	C	E'
56.0	-	-	C'	-	-
68.0	-	C'	-	E'	F'
82.0	-	-	C	-	-
100.0	C'	-	E'	F'	-
120.0	C	C	-	-	E
150.0	-	E'	-	-	-
180.0	-	-	F'	E	F
220.0	E'	F'	-	-	-
270.0	-	-	E	F	-
330.0	F'	-	-	-	-
390.0	-	E	-	-	-
470.0	-	-	F	-	-
560.0	E	-	-	-	-
680.0	-	F	-	-	-
820.0	F	-	-	-	-
1500.0	F_0	-	-	-	-
2200.0	G	-	-	-	-

Notes
(1) WV = Rated Voltage.
(2) (SV) = Surge Voltage (at room temperature).

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 to 300 kHz (mΩ)
C'	94SP226X0020CBP	20.0	22.0	1580	44.00	0.06	50
	94SP336X0016CBP	16.0	33.0	1580	52.80	0.06	50
	94SP566X0010CBP	10.0	56.0	1710	56.00	0.06	45
	94SP686X06R3CBP	6.3	68.0	1850	42.84	0.06	40
	94SP107X0004CBP	4.0	100.0	1850	40.00	0.06	40
E'	94SP476X0020EBP	20.0	47.0	2210	94.00	0.07	36
	94SP686X0016EBP	16.0	68.0	2280	108.80	0.07	34
	94SP107X0010EBP	10.0	100.0	2350	100.00	0.07	32
	94SP157X06R3EBP	6.3	150.0	2420	94.50	0.07	30
	94SP227X0004EBP	4.0	220.0	2510	88.00	0.07	28

Note
(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SP107X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

STANDARD RATINGS

CASE CODE	PART NUMBER (1)	RATED VOLTAGE (V)	NOMINAL CAPACITANCE (µF)	ALLOWABLE RIPPLE CURRENT (mA) at 100 kHz, + 45 °C	MAX. LEAKAGE CURRENT (µA) (after 2 min)	MAX. TANGENT OF LOSS ANGLE	MAX. ESR 100 to 300 kHz (mΩ)
F'	94SP686X0020FBP	20.0	68.0	2800	136.00	0.07	34
	94SP107X0016FBP	16.0	100.0	2890	160.00	0.07	32
	94SP187X0010FBP	10.0	180.0	2990	180.00	0.07	30
	94SP227X06R3FBP	6.3	220.0	3100	138.60	0.07	28
	94SP337X0004FBP	4.0	330.0	3230	132.00	0.07	24
C	94SP336X0020CBP	20.0	33.0	1710	66.00	0.07	45
	94SP476X0016CBP	16.0	47.0	1710	75.20	0.07	45
	94SP826X0010CBP	10.0	82.0	1850	82.00	0.07	40
	94SP127X06R3CBP	6.3	120.0	1930	75.60	0.07	35
	94SP157X0004CBP	4.0	120.0	1930	60.00	0.07	35
E	94SP127X0020EBP	20.0	120.0	3110	200.00	0.08	24
	94SP187X0016EBP	16.0	180.0	3410	288.00	0.08	20
	94SP277X0010EBP	10.0	270.0	3600	270.00	0.08	18
	94SP397X06R3EBP	6.3	390.0	3810	245.70	0.08	16
	94SP567X0004EBP	4.0	560.0	4080	224.00	0.08	14
F	94SP187X0020FBP	20.0	180.0	4280	360.00	0.08	20
	94SP277X0016FBP	16.0	270.0	4400	432.00	0.08	18
	94SP477X0010FBP	10.0	470.0	4510	470.00	0.08	15
	94SP687X06R3FBP	6.3	680.0	4840	428.40	0.08	13
	94SP827X0004FBP	4.0	820.0	5040	328.00	0.08	12
F_0	94SP158X0004FBP	4.0	1500.0	6500	600.00	0.10	10
G	94SP228X0004GBP	4.0	2200.0	7100	880.00	0.12	10

Note

(1) Part Numbers shown are for ± 20 % capacitance tolerance (X0).
94SP107X0016... Part Number is complete with Case Code and 2 character Package or Process Code. BP as shown indicates Bulk Pack.

Vishay Sprague

Contents

Aluminum Capacitors
+ 85 °C, Miniature, Radial Lead

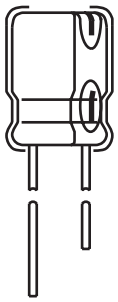


Fig.1 Component outline

FEATURES

- High CV per case size
- Low cost
- Low profile ratings

Pb-free

e3

RoHS
COMPLIANT

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.157" x 0.276" [4.0 x 7.0] to 0.709" x 1.575" [18.0 x 40.0]
Operating temperature	- 40 °C to + 85 °C - 25 °C to + 85 °C for 315 WVDC to 450 WVDC units
Rated Capacitance range, C_R	0.1 µF to 18 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 450 WVDC
Termination	2 radial leads
Life validation test at 85 °C	2000 hours: ΔCAP ± 20 % from initial measurement. ΔDF 2 x initial specified limit. ΔDCL ≤ initial specified limit
Shelf life at 85 °C	1000 hours: ΔCAP ± 20 % from initial measurement. ΔDF 2 x initial specified limit. ΔDCL ≤ initial specified limit
DC leakage current	rated voltage for 1 and 2 minutes for 6.3 WVDC to 100 WVDC units: I < 0.03 CV or 4 µA (whichever is greater). I < 0.04 CV or 3 µA (whichever is greater). rated voltage for 1 minute for 160 WVDC to 450 WVDC units: I < 0.1 CV + 40 µA and CV ≤ 1000; I < 0.04 CV + 100 µA and CV > 1000

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE						
Ambient Temperature				Multipliers		
≤ + 70 °C				1.27		
+ 85 °C				1.0		
FREQUENCY (Hz)						
WVDC	**Cap. (µF)**	**50 - 60**	**100 - 120**	**300 - 400**	**1 kHz**	**≤ 10 kHz**
6.3 - 100	0 - 47	0.75	1	1.35	1.57	2.00
	100 - 470	0.80	1	1.23	1.34	1.50
	1000 - 18 000	0.85	1	1.10	1.13	1.15
160 - 450	0.47 - 220	0.80	1	1.25	1.40	1.60

LOW TEMPERATURE PERFORMANCE

MAXIMUM IMPEDANCE RATIO $Z^{(T)}/Z^{(+ 20 °C)}$ MAXIMUM AT 120 Hz		
Rated Voltage (WVDC)	**Z - 25 °C/Z + 20 °C**	**Z - 40 °C/Z + 20 °C**
6.3	4.0	10.0
10.0	3.0	8.0
16.0	2.0	6.0
25.0	2.0	4.0
35.0 - 100.0	2.0	3.0
160.0 - 200.0	3.0	4.0
250.0	3.0	6.0
315.0 - 400.0	6.0	-
450.0	15.0	-

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL CASE SIZE D x L	LEAD SPACING S	NOMINAL LEAD DIAMETER D	TYPICAL WEIGHT (g)
HW	0.157 x 0.276 [4.0 x 7.0]	0.059 [1.5]	0.018 [0.45]	0.20
JW	0.197 x 0.276 [5.0 x 7.0]	0.079 [2.0]	0.018 [0.45]	0.30
AW	0.248 x 0.276 [6.3 x 7.0]	0.098 [2.5]	0.018 [0.45]	0.40
JA	0.197 x 0.433 [5.0 x 11.0]	0.079 [2.0]	0.020 [0.50]	0.44
AA	0.248 x 0.433 [6.3 x 11.0]	0.098 [2.5]	0.020 [0.50]	0.60
BB	0.315 x 0.453 [8.0 x 11.5]	0.138 [3.5]	0.024 [0.60]	0.95

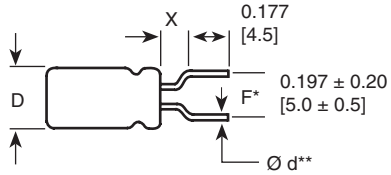
For technical questions, contact: aluminumcaps4@vishay.com
Document Number: 42052
Revision: 13-Jun-08

Aluminum Capacitors
+ 85 °C, Miniature, Radial Lead

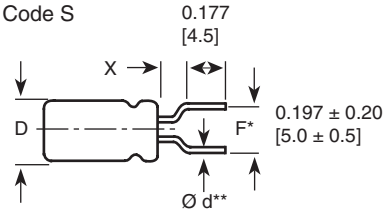
DIMENSIONS in inches [millimeters]				
CASE CODE	**NOMINAL CASE SIZE D x L**	**LEAD SPACING S**	**NOMINAL LEAD DIAMETER D**	**TYPICAL WEIGHT (g)**
CC	0.394 x 0.492 [10.0 x 12.5]	0.197 [5.0]	0.024 [0.60]	1.48
CD	0.394 x 0.630 [10.0 x 16.0]	0.197 [5.0]	0.024 [0.60]	1.75
CG	0.394 x 0.787 [10.0 x 20.0]	0.197 [5.0]	0.024 [0.60]	2.37
DG	0.492 x 0.787 [12.5 x 20.0]	0.197 [5.0]	0.024 [0.60]	3.73
DK	0.492 x 0.984 [12.5 x 25.0]	0.197 [5.0]	0.024 [0.60]	4.85
EK	0.630 x 0.984 [16.0 x 25.0]	0.295 [7.5]	0.031 [0.80]	7.08
EN	0.630 x 1.240 [16.0 x 31.5]	0.295 [7.5]	0.031 [0.80]	8.94
ER	0.630 x 1.398 [16.0 x 35.5]	0.295 [7.5]	0.031 [0.80]	10.50
FR	0.709 x 1.398 [18.0 x 35.5]	0.295 [7.5]	0.031 [0.80]	12.53
FV	0.709 x 1.575 [18.0 x 40.0]	0.295 [7.5]	0.031 [0.80]	15.71

ELECTROLYTIC CAPACITOR WITH CUT OR FORMED LEADS in inches [millimeters]

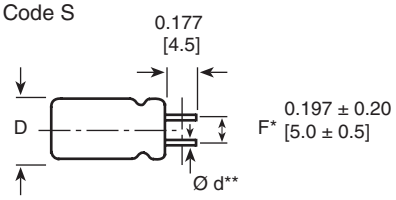
Code F



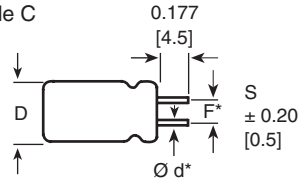
Code S



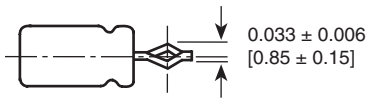
Code S



Code C

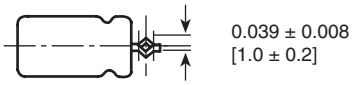


Code S



(4, 5, 6.3, 8)

Code S



(10, 12.5, 16, 18)

DIMENSIONS in inches [millimeters]						
FORMING METHOD	**FORMED LEAD CODE**	**DIMENSIONS**				
		D	**L.S.**	**P**	**e*** **	**X (Max.)**
Formed and Cut	F	0.157 [4.0]	0.197 [5.0]	0.059 [1.5]	-	0.059 [1.5]
		0.197 [5.0]	0.197 [5.0]	0.079 [2.0]	-	0.059 [1.5]
		0.248 [6.3]	0.197 [5.0]	0.098 [2.5]	-	0.098 [2.5]
		0.315 [8.0]	0.197 [5.0]	0.138 [3.5]	-	0.098 [2.5]
Cut	C	0.394 [10.0]	0.197 [5.0]	-	-	-
		0.492 [12.5]	0.197 [5.0]	-	-	-
		0.630 [16.0]	0.295 [7.5]	-	-	-
		0.709 [18.0]	0.295 [7.5]	-	-	-
Snap-in	S	0.157 [4.0]	0.197 [5.0]	0.059 [1.5]	0.043 [1.1]	0.059 [1.5]
		0.197 [5.0]	0.197 [5.0]	0.079 [2.0]	0.043 [1.1]	0.059 [1.5]
		0.248 [6.3]	0.197 [5.0]	0.098 [2.5]	0.043 [1.1]	0.059 [1.5]
		0.315 [8.0]	0.197 [5.0]	0.138 [3.5]	0.051 [1.3]	0.059 [1.5]
		0.394 [10.0]	0.197 [5.0]	-	0.051 [1.3]	-
		0.492 [12.5]	0.197 [5.0]	-	0.051 [1.3]	-
		0.630 [16.0]	0.295 [7.5]	-	0.051 [1.3]	-
		0.709 [18.0]	0.295 [7.5]	-	0.051 [1.3]	-

Note

Coding of cut or formed lead to be added to the end of type number in 15th position (with position 14 coded “6”).

* Formed lead. ** Lead thickness Ø d depends on capacitor specification. *** Lead protrusion at bottom of tape.

TAPED CAPACITORS FOR AUTOMATIC INSERTION SYSTEMS in inches [millimeters]					
PACKAGING	**LEAD CODE 14th AND 15th DIGITS OF PN**	**SPECIFICATION**		**LEAD SPACE**	**CAPACITOR SIZES AVAILABLE**
		LEAD STYLE	**+ - LEADER**		
Ammo Pack	8P	Formed Lead (1)	-	0.197 [5.0]	0.157 x 0.276 - 0.492 x 0.787 [4.0 x 7.0 - 12.5 x 20.0]
					CASE CODES HW, JW, AW, JA, AA, BB, CC, CD, DG

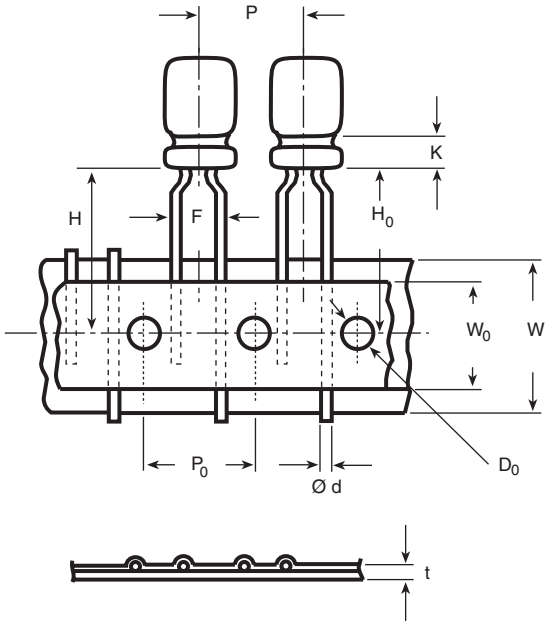
Note

The ammo pack code is to be added at the end of part number in the 14th and 15th position as 8P. To specify formed, cut or snap-in leads and for tape and ammo, both positions 14 and 15 of the type number must be filled in with the proper codes.

(1) Except 0.394 [10.0 mm] and 0.492 [12.5 mm] diameter have straight unformed leads.

TAPING SPECIFICATIONS in inches [millimeters]

Formed Lead Type



DIMENSIONS in inches [millimeters]								
ITEM	**CASE SIZE (Diameter x Length)**							
	FORMED LEAD TYPE						**STRAIGHT LEAD TYPE**	
	0.157 x 0.276 [4.0 x 7.0]	**0.197 x 0.276 [5.0 x 7.0]**	**0.197 x 0.433 [5.0 x 11.0]**	**0.248 x 0.276 [6.3 x 7.0]**	**0.248 x 0.433 [6.3 x 11.0]**	**0.315 x 0.453 [8.0 x 11.5]**	**0.394 [10.0] (Dia.)**	**0.492 [12.5] (Dia.)**
Ø d - Lead-wire Diameter	0.018 [0.45]	0.018 [0.45]	0.020 [0.5]	0.018 [0.45]	0.020 [0.5]	0.024 [0.6]	0.024 [0.6]	0.024 [0.6]
P - Pitch of Component	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.591 [15.0]
P_0 - Feed Hole Pitch	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.591 [15.0]
F - Lead-to-lead Distance	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]
K - Clinch Height	0.059 [1.5]	0.059 [1.5]	0.098 [2.5]	0.059 [1.5]	0.098 [2.5]	0.157 [4.0]	-	-
H - Height of Component	0.689 [17.5]	0.689 [17.5]	0.728 [18.5]	0.689 [17.5]	0.728 [18.5]	0.787 [20.0]	0.728 [18.5]	0.630 [16.0]
H_0 - Lead-wire Clinch Height	0.630 [16.0]	0.630 [16.0]	0.630 [16.0]	0.630 [16.0]	0.630 [16.0]	0.630 [16.0]	-	-
W - Tape Width	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0 - Hold Down Tape Width	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]
D_0 - Feed Hole Diameter	0.157[4.0]	0.157[4.0]	0.157[4.0]	0.157[4.0]	0.157[4.0]	0.157[4.0]	0.157[4.0]]	0.157[4.0]
t - Total Tape Thickness	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]

Aluminum Capacitors
+ 85 °C, Miniature, Radial Lead

ORDERING EXAMPLE

Electrolytic capacitor 515D series: 515D 107 M 6R3 JA 6 A E3

DESCRIPTION	
CODE	**EXPLANATION**
515D	product type
107	capacitance value (100 µF)
M	tolerance (M = ± 20 %)
6R3	voltage rating at 85 °C (6R3 = 6.3 V)
JA	can size (see dimensions table)
6	packaging (bulk)
A	lead style (uncut)
E3	RoHS compliant indicator

PACKING AND LEAD STYLES:

6A	Bulk, uncut leads
6C	Bulk, cut leads
6F	Bulk; formed and cut leads
6S	Bulk, snap-in leads
8P	Ammopack (case codes HW, JW, AW, JA, AA, BB, CC, CD, CG, DG only)

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	MAX. RIPPLE AT + 85 °C 120 Hz (mA)	MAX. DF AT + 20 °C 120 Hz
6.3 WVDC at + 85 °C, SURGE = 8 V				
22.0	515D226M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	34.0	0.24
33.0	515D336M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	42.0	0.24
47.0	515D476M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	50.0	0.24
100.0	515D107M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	77.0	0.24
220.0	515D227M6R3AA6AE3	0.248 x 0.433 [6.3 x 11.0]	215.0	0.24
330.0	515D337M6R3AA6AE3	0.248 x 0.433 [6.3 x 11.0]	265.0	0.24
470.0	515D477M6R3BB6AE3	0.315 x 0.453 [8.0 x 11.5]	360.0	0.24
1000.0	515D108M6R3CC6AE3	0.394 x 0.492 [10.0 x 12.5]	570.0	0.24
2200.0	515D228M6R3DG6AE3	0.492 x 0.787 [12.5 x 20.0]	1050.0	0.24
3300.0	515D338M6R3DG6AE3	0.492 x0 .787 [12.5 x 20.0]	1250.0	0.24
4700.0	515D478M6R3EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1700.0	0.24
6800.0	515D688M6R3EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1900.0	0.24
10 000.0	515D109M6R3EN6AE3	0.630 x 1.240 [16.0 x 31.5]	2250.0	0.24
15 000.0	515D159M6R3FR6AE3	0.709 x 1.398 [18.0 x 35.5]	2680.0	0.24
18 000.0	515D189M6R3FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2750.0	0.24
10 WVDC at + 85 °C, SURGE = 13 V				
22.0	515D226M010JA6AE3	0.197 x0 .433 [5.0 x 11.0]	38.0	0.20
33.0	515D336M010JA6AE3	0.197 x 0.433 [5.0 x 11.0]	47.0	0.20
47.0	515D476M010JA6AE3	0.197 x 0.433 [5.0 x 11.0]	59.0	0.20
100.0	515D107M010JA6AE3	0.197 x 0.433 [5.0 x 11.0]	145.0	0.20
220.0	515D227M010AA6AE3	0.248 x 0.433 [6.3 x 11.0]	230.0	0.20
330.0	515D337M010BB6AE3	0.315 x 0.453 [8.0 x 11.5]	330.0	0.20
470.0	515D477M010BB6AE3	0.315 x 0.453 [8.0 x 11.5]	390.0	0.20
1000.0	515D108M010CD6AE3	0.394 x 0.630 [10.0 x 16.0]	630.0	0.20
2200.0	515D228M010DG6AE3	0.492 x .0787 [12.5 x 20.0]	1100.0	0.20
3300.0	515D338M010DK6AE3	0.492 x 0.984 [12.5 x 25.0]	1400.0	0.20
4700.0	515D478M010EK6AE3	0.630 x .0984 [16.0 x 25.0]	1800.0	0.20
6800.0	515D688M010EN6AE3	0.630 x 1.240 [16.0 x 31.5]	2150.0	0.20
10 000.0	515D109M010FR6AE3	0.709 x 1.398 [18.0 x 35.5]	2500.0	0.20
15 000.0	515D159M010FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2720.0	0.20

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	MAX. RIPPLE AT + 85 °C 120 Hz (mA)	MAX. DF AT + 20 °C 120 Hz
16 WVDC at + 85 °C, SURGE = 20 V				
10.0	515D106M016JA6AE3	0.197 x .433 [5.0 x 11.0]	28.0	0.16
22.0	515D226M016JA6AE3	0.197 x 0.433 [5.0 x 11.0]	44.0	0.16
33.0	515D336M016JA6AE3	0.197 x 0.433 [5.0 x 11.0]	57.0	0.16
47.0	515D476M016JA6AE3	0.197 x 0.433 [5.0 x 11.0]	168.0	0.16
16 WVDC at + 85 °C, SURGE = 20 V				
100.0	515D107M016AA6AE3	0.248 x 0.433 [6.3 x 11.0]	175.0	0.16
220.0	515D227M016BB6AE3	0.315 x 0.453 [8.0 x 11.5]	300.0	0.16
330.0	515D337M016BB6AE3	0.315 x 0.453 [8.0 x 11.5]	360.0	0.16
470.0	515D477M016CC6AE3	0.394 x 0.492 [10.0 x 12.5]	470.0	0.16
1000.0	515D108M016CG6AE3	0.394 x 0.787 [10.0 x 20.0]	790.0	0.16
2200.0	515D228M016DK6AE3	0.492 x 0.984 [12.5 x 25.0]	1350.0	0.16
3300.0	515D338M016EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1700.0	0.16
4700.0	515D478M016EN6AE3	0.630 x 1.240 [16.0 x 31.5]	2100.0	0.16
6800.0	515D688M016FR6AE3	0.709 x 1.398 [18.0 x 35.5]	2500.0	0.16
10 000.0	515D109M016FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2640.0	0.16
25 WVDC at + 85 °C, SURGE = 32 V				
4.7	515D475M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	30.0	0.14
10.0	515D106M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	33.0	0.14
22.0	515D226M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	51.0	0.14
33.0	515D336M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	63.0	0.14
47.0	515D476M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	115.0	0.14
100.0	515D107M025AA6AE3	0.248 x 0.433 [6.3 x 11.0]	185.0	0.14
220.0	515D227M025BB6AE3	0.315 x 0.453 [8.0 x 11.5]	320.0	0.14
330.0	515D337M025CC6AE3	0.394 x 0.492 [10.0 x 12.5]	420.0	0.14
470.0	515D477M025CD6AE3	0.394 x 0.630 [10.0 x 16.0]	540.0	0.14
1000.0	515D108M025DG6AE3	0.492 x 0.787 [12.5 x 20.0]	950.0	0.14
2200.0	515D228M025EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1550.0	0.14
3300.0	515D338M025EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1950.0	0.14
4700.0	515D478M025FR6AE3	0.709 x 1.398 [18.0 x 35.5]	2360.0	0.14
35 WVDC at + 85 °C, SURGE = 44 V				
4.7	515D475M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	24.0	0.12
10.0	515D106M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	36.0	0.12
22.0	515D226M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	57.0	0.12
33.0	515D336M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	105.0	0.12
47.0	515D476M035AA6AE3	0.248 x 0.433 [6.3 x 11.0]	140.0	0.12
100.0	515D107M035BB6AE3	0.315 x 0.453 [8.0 x 11.5]	230.0	0.12
220.0	515D227M035CC6AE3	0.394 x 0.492 [10.0 x 12.5]	370.0	0.12
330.0	515D337M035CD6AE3	0.394 x 0.630 [10.0 x 16.0]	490.0	0.12
470.0	515D477M035CG6AE3	0.394 x 0.787 [10.0 x 20.0]	640.0	0.12
1000.0	515D108M035DK6AE3	0.492 x 0.984 [12.5 x 25.0]	1100.0	0.12
2200.0	515D228M035EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1850.0	0.12
3300.0	515D338M035FR6AE3	0.709 x 1.382 [18.0 x 35.5]	2220.0	0.12
4700.0	515D478M035FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2490.0	0.12
50 WVDC at + 85 °C, SURGE = 63 V				
0.1	515D104M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	1.0	0.10
0.22	515D224M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	2.3	0.10
0.33	515D334M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	3.5	0.10
0.47	515D474M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	5.0	0.10
1.0	515D105M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	10.0	0.10
2.2	515D225M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	19.0	0.10
3.3	515D335M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	24.0	0.10
4.7	515D475M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	29.0	0.10

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	MAX. RIPPLE AT + 85 °C 120 Hz (mA)	MAX. DF AT + 20 °C 120 Hz
50 WVDC at + 85 °C, SURGE = 63 V				
10.0	515D106M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	44.0	0.10
22.0	515D226M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	95.0	0.10
33.0	515D336M050AA6AE3	0.248 x 0.433 [6.3 x 11.0]	125.0	0.10
47.0	515D476M050AA6AE3	0.248 x 0.433 [6.3 x 11.0]	150.0	0.10
100.0	515D107M050BB6AE3	0.315 x 0.453 [8.0 x 11.5]	250.0	0.10
220.0	515D227M050CD6AE3	0.394 x 0.630 [10.0 x 16.0]	440.0	0.10
330.0	515D337M050CG6AE3	0.394 x 0.787 [10.0 x 20.0]	580.0	0.10
470.0	515D477M050DG6AE3	0.492 x 0.787 [12.5 x 20.0]	760.0	0.10
1000.0	515D108M050EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1350.0	0.10
2200.0	515D228M050FR6AE3	0.709 x 1.398 [18.0 x 35.5]	2090.0	0.10
63 WVDC at + 85 °C, SURGE = 79 V				
4.7	515D475M063JA6AE3	0.197 x 0.433 [5.0 x 11.0]	45.0	0.08
10.0	515D106M063JA6AE3	0.197 x 0.433 [5.0 x 11.0]	70.0	0.08
22.0	515D226M063AA6AE3	0.248 x 0.433 [6.3 x 11.0]	115.0	0.08
33.0	515D336M063AA6AE3	0.248 x 0.433 [6.3 x 11.0]	140.0	0.08
47.0	515D476M063BB6AE3	0.315 x 0.453 [8.0 x 11.5]	190.0	0.08
100.0	515D107M063CC6AE3	0.394 x 0.492 [10.0 x 12.5]	300.0	0.08
220.0	515D227M063CG6AE3	0.394 x 0.787 [10.0 x 20.0]	490.0	0.08
330.0	515D337M063DG6AE3	0.492 x 0.787 [12.5 x 20.0]	680.0	0.08
470.0	515D477M063DK6AE3	0.492 x 0.984 [12.5 x 25.0]	880.0	0.08
1000.0	515D108M063EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1550.0	0.08
2200.0	515D228M063FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2200.0	0.08
100 WVDC at + 85 °C, SURGE = 125 V				
0.1	515D104M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	2.1	0.08
0.22	515D224M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	4.7	0.08
0.33	515D334M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	7.0	0.08
0.47	515D474M100JA6AE3	0.197 x .0433 [5.0 x 11.0]	10.0	0.08
1.0	515D105M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	21.0	0.08
2.2	515D225M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	30.0	0.08
3.3	515D335M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	40.0	0.08
4.7	515D475M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	45.0	0.08
10.0	515D106M100AA6AE3	0.248 x 0.433 [6.3 x 11.0]	75.0	0.08
22.0	515D226M100BB6AE3	0.315 x 0.453 [8.0 x 11.5]	130.0	0.08
33.0	515D336M100CC6AE3	0.394 x 0.492 [10.0 x 12.5]	170.0	0.08
47.0	515D476M100CD6AE3	0.394 x 0.630 [10.0 x 16.0]	230.0	0.08
100.0	515D107M100DG6AE3	0.492 x 0.787 [12.5 x 20.0]	400.0	0.08
220.0	515D227M100EK6AE3	0.630 x 0.984 [16.0 x 25.0]	710.0	0.08
330.0	515D337M100EK6AE3	0.630 x 0.984 [16.0 x 25.0]	860.0	0.08
470.0	515D477M100EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1100.0	0.08
1000.0	515D108M100FV6AE3	0.709 x 1.575 [18.0 x 40.0]	1690.0	0.08
160 WVDC at + 85 °C, SURGE = 200 V				
0.47	515D474M160AA6AE3	0.248 x 0.433 [6.3 x 11.0]	12.0	0.20
1.0	515D105M160AA6AE3	0.248 x 0.433 [6.3 x 11.0]	17.0	0.20
2.2	515D225M160AA6AE3	0.248 x 0.433 [6.3 x 11.0]	26.0	0.20
3.3	515D335M160BB6AE3	0.315 x 0.453 [8.0 x 11.5]	35.0	0.20
4.7	515D475M160BB6AE3	0.315 x 0.453 [8.0 x 11.5]	40.0	0.20
10.0	515D106M160CC6AE3	0.394 x 0.492 [10.0 x 12.5]	65.0	0.20
22.0	515D226M160CG6AE3	0.394 x 0.787 [10.0 x 20.0]	110.0	0.20
33.0	515D336M160DG6AE3	0.492 x 0.787 [12.5 x 20.0]	150.0	0.20
47.0	515D476M160DK6AE3	0.492 x 0.984 [12.5 x 25.0]	180.0	0.20
100.0	515D107M160EK6AE3	0.630 x 0.984 [16.0 x 25.0]	300.0	0.20
220.0	515D227M160FR6AE3	0.709 x 1.398 [18.0 x 35.5]	510.0	0.20

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	MAX. RIPPLE AT + 85 °C 120 Hz (mA)	MAX. DF AT + 20 °C 120 Hz
200 WVDC at + 85 °C, SURGE = 250 V				
0.47	515D474M200AA6AE3	0.248 x 0.433 [6.3 x 11.0]	12.0	0.20
1.0	515D105M200AA6AE3	0.248 x 0.433 [6.3 x 11.0]	17.0	0.20
2.2	515D225M200AA6AE3	0.248 x 0.433 [6.3 x 11.0]	26.0	0.20
3.3	515D335M200BB6AE3	0.315 x 0.453 [8.0 x 11.5]	35.0	0.20
4.7	515D475M200CC6AE3	0.394 x 0.492 [10.0 x 12.5]	45.0	0.20
10.0	515D106M200CD6AE3	0.394 x 0.630 [10.0 x 16.0]	70.0	0.20
22.0	515D226M200CG6AE3	0.394 x 0.787 [10.0 x 20.0]	110.0	0.20
33.0	515D336M200DK6AE3	0.492 x 0.984 [12.5 x 25.0]	160.0	0.20
47.0	515D476M200DK6AE3	0.492 x 0.984 [12.5 x 25.0]	180.0	0.20
100.0	515D107M200EN6AE3	0.630 x 1.240 [16.0 x 31.5]	330.0	0.20
220.0	515D227M200FV6AE3	0.709 x 1.575 [18.0 x 40.0]	520.0	0.20
250 WVDC at + 85 °C, SURGE = 300 V				
0.47	515D474M250AA6AE3	0.248 x 0.433 [6.3 x 11.0]	12.0	0.20
1.0	515D105M250AA6AE3	0.248 x 0.433 [6.3 x 11.0]	17.0	0.20
2.2	515D225M250BB6AE3	0.315 x 0.453 [8.0 x 11.5]	30.0	0.20
3.3	515D335M250CC6AE3	0.394 x 0.492 [10.0 x 12.5]	35.0	0.20
4.7	515D475M250CC6AE3	0.394 x 0.492 [10.0 x 12.5]	45.0	0.20
10.0	515D106M250CG6AE3	0.394 x 0.787 [10.0 x 20.0]	70.0	0.20
33.0	515D336M250DK6AE3	0.492 x 0.984 [12.5 x 25.0]	160.0	0.20
47.0	515D476M250EK6AE3	0.630 x 1.240 [16.0 x 31.5]	210.0	0.20
100.0	515D107M250FR6AE3	0.709 x 1.575 [18.0 x 40.0]	340.0	0.20
315 WVDC at + 85 °C, SURGE = 365 V				
1.0	515D105M315AA6AE3	0.248 x 0.433 [6.3 x 11.0]	17.0	0.20
2.2	515D225M315BB6AE3	0.315 x 0.453 [8.0 x 11.5]	30.0	0.20
3.3	515D335M315CC6AE3	0.394 x 0.492 [10.0 x 12.5]	35.0	0.20
4.7	515D475M315CD6AE3	0.394 x 0.630 [10.0 x 16.0]	45.0	0.20
10.0	515D106M315CG6AE3	0.394 x 0.787 [10.0 x 20.0]	70.0	0.20
22.0	515D226M315DK6AE3	0.492 x 0.984 [12.5 x 25.0]	120.0	0.20
33.0	515D336M315EK6AE3	0.630 x 0.984 [16.0 x 25.0]	150.0	0.20
47.0	515D476M315EN6AE3	0.630 x 1.240 [16.0 x 31.5]	190.0	0.20
100.0	515D107M315FV6AE3	0.709 x 1.575 [18.0 x 40.0]	340.0	0.20
350 WVDC at + 85 °C, SURGE = 400 V				
1.0	515D105M350BB6AE3	0.315 x .453 [8.0 x 11.5]	18.0	0.25
2.2	515D225M350CC6AE3	0.394 x .492 [10.0 x 12.5]	28.0	0.25
3.3	515D335M350CD6AE3	0.394 x .630 [10.0 x 16.0]	35.0	0.25
4.7	515D475M350CD6AE3	0.394 x .630 [10.0 x 16.0]	40.0	0.25
10.0	515D106M350DG6AE3	0.492 x .787 [12.5 x 20.0]	70.0	0.25
22.0	515D226M350DK6AE3	0.492 x .984 [12.5 x 25.0]	110.0	0.25
33.0	515D336M350EN6AE3	0.630 x 1.240 [16.0 x 31.5]	140.0	0.25
47.0	515D476M350FR6AE3	0.709 x 1.398 [18.0 x 35.5]	220.0	0.25
400 WVDC at + 85 °C, SURGE = 450 V				
1.0	515D105M400BB6AE3	0.315 x 0.453 [8.0 x 11.5]	18.0	0.25
2.2	515D225M400CC6AE3	0.394 x 0.492 [10.0 x 12.5]	28.0	0.25
3.3	515D335M400CD6AE3	0.394 x 0.630 [10.0 x 16.0]	35.0	0.25
4.7	515D475M400CD6AE3	0.394 x 0.787 [10.0 x 20.0]	45.0	0.25
10.0	515D106M400DG6AE3	0.492 x 0.787 [12.5 x 20.0]	70.0	0.25
22.0	515D226M400DK6AE3	0.630 x 0.984 [16.0 x 25.0]	110.0	0.25
33.0	515D336M400EN6AE3	0.630 x 1.240 [16.0 x 31.5]	140.0	0.25
47.0	515D476M400FR6AE3	0.709 x 1.398 [18.0 x 35.5]	220.0	0.25

ELECTRICAL DATA AND ORDERING INFORMATION				
CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	MAX. RIPPLE AT + 85 °C 120 Hz (mA)	MAX. DF AT + 20 °C 120 Hz
450 WVDC at + 85 °C, SURGE = 500 V				
1.0	515D105M450CC6AE3	0.394 x 0.492 [10.0 x 12.5]	19.0	0.25
2.2	515D225M450CD6AE3	0.394 x 0.630 [10.0 x 16.0]	29.0	0.25
4.7	515D475M450DG6AE3	0.492 x 0.787 [12.5 x 20.0]	50.0	0.25
10.0	515D106M450EK6AE3	0.492 x 0.984 [12.5 x 25.0]	75.0	0.25
22.0	515D226M450EN6AE3	0.630 x 1.240 [16.0 x 31.5]	110.0	0.25
33.0	515D336M450FR6AE3	0.709 x 1.398 [18.0 x 35.5]	170.0	0.25

LOW PROFILE RATINGS in inches [millimeters]				
CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	MAX. RIPPLE AT + 85 °C 120 Hz (mA)	MAX. DF AT + 20 °C 120 Hz
6.3 WVDC at + 85 °C, SURGE = 8 V				
22.0	515D226M6R3HW6AE3	0.157 x 0.276 [4.0 x 7.0]	34.0	0.24
33.0	515D336M6R3JW6AE3	0.197 x 0.276 [5.0 x 7.0]	42.0	0.24
47.0	515D476M6R3JW6AE3	0.197 x 0.276 [5.0 x 7.0]	50.0	0.24
100.0	515D107M6R3AW6AE3	0.248 x 0.276 [6.3 x 7.0]	77.0	0.24
10 WVDC at + 85 °C, SURGE = 13 V				
22.0	515D226M010JW6AE3	0.197 x 0.276 [5.0 x 7.0]	38.0	0.20
33.0	515D336M010JW6AE3	0.197 x 0.276 [5.0 x 7.0]	47.0	0.20
47.0	515D476M010AW6AE3	0.248 x 0.276 [6.3 x 7.0]	59.0	0.20
16 WVDC at + 85 °C, SURGE = 20 V				
10.0	515D106M016HW6AE3	0.157 x 0.276 [4.0 x 7.0]	28.0	0.16
22.0	515D226M016JW6AE3	0.197 x 0.276 [5.0 x 7.0]	44.0	0.16
33.0	515D336M016AW6AE3	0.248 x 0.276 [6.3 x 7.0]	57.0	0.16
47.0	515D476M016AW6AE3	0.248 x 0.276 [6.3 x 7.0]	68.0	0.16
25 WVDC at + 85 °C, SURGE = 32 V				
10.0	515D106M025JW6AE3	0.197 x 0.276 [5.0 x 7.0]	33.0	0.14
22.0	515D226M025AW6AE3	0.248 x 0.276 [6.3 x 7.0]	51.0	0.14
33.0	515D336M025AW6AE3	0.248 x 0.276 [6.3 x 7.0]	63.0	0.14
35 WVDC at + 85 °C, SURGE = 44 V				
4.7	515D475M035HW6AE3	0.157 x 0.276 [4.0 x 7.0]	24.0	0.12
10.0	515D106M035JW6AE3	0.197 x 0.276 [5.0 x 7.0]	36.0	0.12
22.0	515D226M035AW6AE3	0.248 x 0.276 [6.3 x 7.0]	57.0	0.12
50 WVDC at + 85 °C, SURGE = 63 V				
0.1	515D104M050JW6AE3	0.157 x 0.276 [4.0 x 7.0]	1.0	0.10
0.22	515D224M050HW6AE3	0.157 x 0.276 [4.0 x 7.0]	2.3	0.10
0.33	515D334M050HW6AE3	0.157 x 0.276 [4.0 x 7.0]	3.5	0.10
0.47	515D474M050HW6AE3	0.157 x 0.276 [4.0 x 7.0]	5.0	0.10
1.0	515D105M050HW6AE3	0.157 x 0.276 [4.0 x 7.0]	10.0	0.10
2.2	515D225M050HW6AE3	0.157 x 0.276 [4.0 x 7.0]	19.0	0.10
3.3	515D335M050HW6AE3	0.157 x 0.276 [4.0 x 7.0]	24.0	0.10
4.7	515D475M050JW6AE3	0.197 x 0.276 [5.0 x 7.0]	29.0	0.10
10.0	515D106M050AW6AE3	0.248 x 0.276 [6.3 x 7.0]	44.0	0.10

Aluminum Capacitors
General Purpose, Miniature, Radial Lead

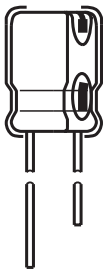


Fig.1 Component outline

FEATURES

- + 105 °C
- Suitable for long life applications

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.236" x 0.433" [6.0 x 11.0] to 0.709" x 1.417" [18.0 x 36.0]
Operating temperature	- 40 °C to + 105 °C
Rated capacitance range, C_R	1 µF to 10 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 250 WVDC
Termination	2 or 3 radial leads
Life validation test at 105 °C	1000 hours (diameter ≤ 0.315" [8.0]): 2000 hours (diameter > 0.315" [8.0]): Δ CAP ≤ 15 % (6.3 WVDC to 16 WVDC), ≤ 10 % (25 WVDC to 250 WVDC) from initial measurement. Δ ESR ≤ 1.2 x initial . specified limit.
Shelf life at 105 °C	500 hours: Δ CAP ≤ 10 % from initial measurement. Δ ESR 1.2 x initial specified limit. Δ DCL ≤ 2 x initial specified limit.
DC leakage current	6.3 WVDC to 63 WVDC units: I = 0.005 CV 100 WVDC to 250 WVDC units: I = 0.01 CV I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE	
Ambient Temperature	**Multipliers**
+ 105 °C	0.4
+ 95 °C	0.7
+ 85 °C	1.0
+ 75 °C	1.2
≤ + 65 °C	1.4

FREQUENCY (Hz)				
WVDC	**50 - 60**	**100 - 120**	**300 - 400**	**1K - 100K**
6.3 - 25	0.85	1.00	1.05	1.1
26 - 250	0.80	1.00	1.30	1.4

LEAD LENGTH FOR D TERMINATION

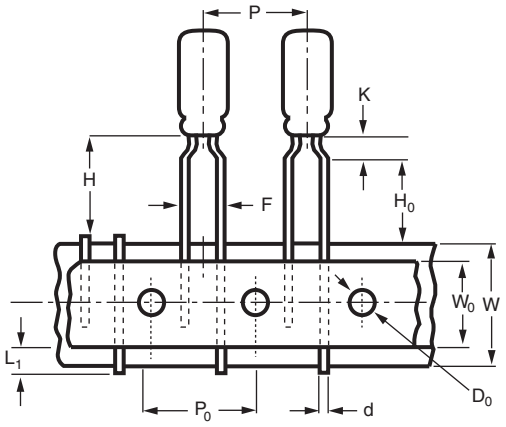
CASE CODE	L_1 (-)	L_2 (+)
D	0.591 [15.0]	0.787 [20.0]

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL		STYLES 2 AND 4		STYLES 3 AND 5		LEAD SPACING		LEAD DIAMETER	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.024 [0.60]	T ± 0.02 [0.50]	NOMINAL	AWG NO.
AA	0.236 [6.0]	0.433 [11.0]	0.256 [6.5]	0.472 [12.0]	0.256 [6.5]	0.512 [13.0]	0.098 [2.5]	N/A	0.025 [0.63]	22
BB	0.315 [8.0]	0.472 [12.0]	0.335 [8.5]	0.512 [13.0]	0.335 [8.5]	0.551 [14.0]	0.138 [3.5]	N/A	0.025 [0.63]	22
CC	0.394 [10.0]	0.512 [13.0]	0.413 [10.5]	0.563 [14.3]	0.413 [10.5]	0.630 [16.0]	0.197 [5.0]	N/A	0.025 [0.63]	22
CD	0.394 [10.0]	0.630 [16.0]	0.413 [10.5]	0.669 [17.0]	0.413 [10.5]	0.740 [18.8]	0.197 [5.0]	N/A	0.025 [0.63]	22
CG	0.394 [10.0]	0.787 [20.0]	0.413 [10.5]	0.846 [21.5]	0.413 [10.5]	0.906 [23.0]	0.197 [5.0]	N/A	0.025 [0.63]	22
DG	0.492 [12.5]	0.787 [20.0]	0.512 [13.0]	0.846 [21.5]	0.512 [13.0]	0.906 [23.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
DK	0.492 [12.5]	0.984 [25.0]	0.512 [13.0]	1.043 [26.5]	0.512 [13.0]	1.142 [29.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
EK	0.630 [16.0]	0.984 [25.0]	0.650 [16.5]	1.031 [26.2]	0.650 [16.5]	1.098 [27.9]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
EN	0.630 [16.0]	1.260 [32.0]	0.650 [16.5]	1.319 [33.5]	0.650 [16.5]	1.417 [36.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
ER	0.630 [16.0]	1.417 [36.0]	0.650 [16.5]	1.476 [37.5]	0.650 [16.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
FR	0.709 [18.0]	1.417 [36.0]	0.728 [18.5]	1.476 [37.5]	0.728 [18.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20

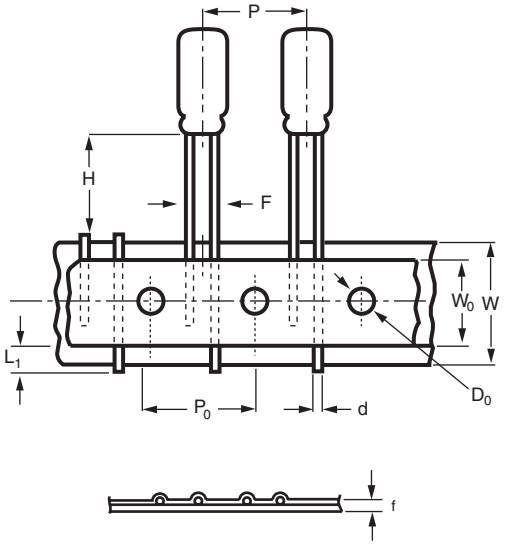
TAPE AND REEL, SPECIFICATIONS TO EIA-468 in inches [millimeters]

Formed Leads



DIMENSIONS in inches [millimeters]		
CASE SIZE	**F LEAD SPACING**	**STD. QTY/REEL**
0.236 x 0.433 [6.0 x 11.0]	0.197 [5.0]	800
0.315 x 0.472 [8.0 x 12.0]	0.197 [5.0]	700

Unformed Leads



DIMENSIONS in inches [millimeters]		
CASE SIZE	**F LEAD SPACING**	**STD. QTY/REEL**
0.236 x 0.433 [6.0 x 11.0]	0.098 (1) [2.5]	800
0.315 x 0.472 [8.0 x 12.0]	0.140 (1) [3.5]	700
0.394 x 0.512 [10.0 x 13.0]	0.197 [5.0]	500
0.394 x 0.630 [10.0 x 16.0]	0.197 [5.0]	500
0.394 x 0.787 [10.0 x 20.0]	0.197 [5.0]	500

Note

(1) Available as special order

DIMENSIONS in inches [millimeters]

ITEM	CASE SIZE (Diameter x Length)				
	0.236 x 0.433 [6.0 x 11.0]	0.315 x 0.472 [8.0 x 12.0]	0.394 x 0.512 [10.0 x 13.0]	0.394 x 0.630 [10.0 x 16.0]	0.394 x 0.787 [10.0 x 20.0]
d - Lead-wire diameter	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [063]	0.020 [0.5]
P - Pitch of component	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
P_0 - Feed hole pitch	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
F - Lead-to-lead distance	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]
K - Clinch height	0.098 [2.5]	0.157 [4.0]	N/A	N/A	N/A
H - Height of component from tape center	0.728 [18.5]	0.787 [20.0]	0.906 [23.0]	0.906 [23.0]	0.906 [23.0]
H_0 - Lead-wire clinch height	0.630 [16.0]	0.630 [16.0]	N/A	N/A	N/A
W - Tape width	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0 - Hold down tape width	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]
D_0 - Feed hole diameter	0.157 [4.0]	0.157[4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]
t - Total tape thickness	0.028 [0.7]	0.028 [0.7]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]
L_1 - Maximum lead protrusion	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]

Note
Terminal code "I" = Tape and reel. Terminal code "+" = Tape and ammo. Positive leader is standard. Negative leader is available by special order.

ORDERING EXAMPLE

Electrolytic capacitor 511D series: 511D 157 M 063 CG 4 D

DESCRIPTION

CODE	EXPLANATION
511D	product type
157	capacitance value (150 µF)
M	tolerance (M = ± 20 %)
063	voltage rating at 105 °C (063 = 63 V)
DF	can size (see dimensions table)
4	sleeve sealing (4 = p.v.c. sleeve)
D	packaging (D = bulk; straight leads)

STANDARD RATINGS in inches [millimeters]

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. ESR at + 25 °C (mΩ)		Max. RIPPLE at + 85 °C		Max. IMPEDANCE at + 25 °C (mΩ) 100 Hz
			120 Hz	20 kHz - 40 kHz	120 Hz	20 kHz - 40 kHz	
6.3 WVDC at + 105 °C, SURGE = 8 V							
150.0	511D157M6R3AA4D	0.236 x 0.433 [6.0 x 11.0]	3.130	2.720	0.123	0.132	2.800
1200.0	511D128M6R3CG4D	0.394 x 0.787 [10.0 x 20.0]	0.420	0.270	0.590	0.741	0.286
4700.0	511D478M6R3EK4D	0.630 x 0.984 [16.0 x 25.0]	0.121	0.075	1.580	2.010	0.090
10 000.0	511D109M6R3FR4D	0.630 x 1.417 [16.0 x 36.0]	0.068	0.050	2.640	3.070	0.061
10 WVDC at + 105 °C, SURGE = 13 V							
100.0 (1)	511D107M010AA4D	0.236 x 0.433 [6.0 x 11.0]	4.073	2.800	0.108	0.131	2.900
220.0 (1)	511D227M010BB4D	0.315 x 0.472 [8.0 x 12.0]	1.855	1.150	0.198	0.252	1.300
1000.0	511D108M010CG4D	0.394 x 0.787 [10.0 x 20.0]	0.407	0.290	0.603	0.715	0.290
3300.0	511D338M010EK4D	0.630 x 0.984 [16.0 x 25.0]	0.166	0.086	1.350	1.880	0.094
4700.0	511D478M010EN4D	0.630 x 1.260 [16.0 x 32.0]	0.122	0.060	1.740	2.480	0.067
16 WVDC at + 105 °C, SURGE = 20 V							
150.0	511D157M016BB4D	0.315 x 0.472 [8.0 x 12.0]	2.433	1.250	0.173	0.241	1.250
470.0 (1)	511D477M016CD4D	0.394 x 0.630 [10.0 x 16.0]	0.748	0.442	0.419	0.522	0.442
1500.0	511D158M016DK4D	0.492 x 0.984 [12.5 x 25.0]	0.243	0.140	0.971	1.270	0.140
2200.0	511D228M016EK4D	0.630 x 0.984 [16.0 x 25.0]	0.176	0.090	1.310	1.840	0.098
3300.0	511D338M016EN4D	0.630 x 1.260 [16.0 x 32.0]	0.147	0.062	1.580	2.440	0.067

Note
(1) These values are normally stocked. See Original Ratings for more values that are stocked.

STANDARD RATINGS in inches [millimeters]							
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR at + 25 °C (mΩ)**		**Max. RIPPLE at + 85 °C**		**Max. IMPEDANCE at + 25 °C (mΩ) 100 Hz**
			120 Hz	**20 kHz - 40 kHz**	**120 Hz**	**20 kHz - 40 kHz**	
20 WVDC at + 105 °C, SURGE = 25 V							
120.0	511D127M020BB4D	0.315 x 0.472 [8.0 x 12.0]	2.650	1.350	0.166	0.232	1.350
220.0	511D227M020CC4D	0.394 x 0.512 [10.0 x 13.0]	1.472	0.950	0.266	0.331	0.900
330.0	511D337M020CD4D	0.394 x 0.630 [10.0 x 16.0]	0.981	0.550	0.350	0.468	0.500
470.0	511D477M020CG4D	0.394 x 0.787 [10.0 x 20.0]	0.679	0.300	0.467	0.703	0.305
1500.0	511D158M020EK4D	0.630 x 0.984 [16.0 x 25.0]	0.243	0.110	1.120	1.660	0.100
2200.0	511D228M020EN4D	0.630 x 1.260 [16.0 x 32.0]	0.163	0.080	1.510	2.150	0.080
3300.0	511D338M020FR4D	0.630 x 1.417 [16.0 x 36.0]	0.128	0.060	1.920	2.810	0.064
25 WVDC at + 105 °C, SURGE = 32 V							
47.0 (1)	511D476M025AA4D	0.236 x 0.433 [6.0 x 11.0]	6.120	2.940	0.089	0.127	2.950
100.0	511D107M025BB4D	0.315 x 0.472 [8.0 x 12.0]	2.914	1.350	0.158	0.232	1.350
1200.0	511D128M025EK4D	0.630 x 0.984 [16.0 x 25.0]	0.239	0.110	1.127	1.660	0.105
2200.0	511D228M025ER4D	0.630 x 1.417 [16.0 x 36.0]	0.162	0.064	1.580	2.520	0.074
35 WVDC at + 105 °C, SURGE = 44 V							
120.0	511D127M035CC4D	0.394 x 0.512 [10.0 x 13.0]	1.830	1.010	0.239	0.323	0.980
330.0	511D337M035CG4D	0.394 x 0.787 [10.0 x 20.0]	0.677	0.305	0.468	0.697	0.310
1000.0	511D108M035EK4D	0.630 x 0.984 [16.0 x 25.0]	0.223	0.110	1.170	1.660	0.112
1500.0	511D158M035EN4D	0.630 x 1.260 [16.0 x 32.0]	0.165	0.078	1.490	2.180	0.078
2200.0	511D228M035FR4D	0.709 x 1.417 [18.0 x 36.0]	0.121	0.060	1.980	2.810	0.062
40 WVDC at + 105 °C, SURGE = 50 V							
100.0	511D107M040CC4D	0.394 x 0.512 [10.0 x 13.0]	1.939	1.010	0.232	0.323	0.981
220.0	511D227M040CG4D	0.394 x 0.787 [10.0 x 20.0]	0.883	0.305	0.411	0.698	0.311
330.0	511D337M040DG4D	0.492 x 0.787 [12.5 x 20.0]	0.588	0.210	0.573	0.959	0.221
470.0	511D477M040DK4D	0.492 x 0.984 [12.5 x 25.0]	0.407	0.151	0.719	1.190	0.157
1000.0	511D108M040EN4D	0.630 x 1.260 [16.0 x 32.0]	0.193	0.078	1.390	2.180	0.078
50 WVDC at + 105 °C, SURGE = 63 V							
47.0	511D476M050BB4D	0.315 x 0.472 [8.0 x 12.0]	3.884	1.510	0.137	0.221	1.450
120.0	511D127M050CD4D	0.394 x 0.630 [10.0 x 16.0]	1.320	0.466	0.302	0.509	0.488
270.0	511D277M050DG4D	0.492 x 0.787 [12.5 x 20.0]	0.601	0.221	0.567	0.937	0.231
1000.0	511D108M050ER4D	0.630 x 1.417 [16.0 x 36.0]	0.161	0.065	1.590	2.510	0.068
1500.0	511D158M050FR4D	0.709 x 1.417 [18.0 x 36.0]	0.153	0.065	1.760	2.710	0.068
63 WVDC at + 105 °C, SURGE = 79 V							
47.0	511D476M063CC4D	0.394 x 0.512 [10.0 x 13.0]	3.076	1.170	0.184	0.299	1.110
150.0	511D157M063CG4D	0.394 x 0.787 [10.0 x 20.0]	1.010	0.331	0.385	0.671	0.341
470.0	511D477M063EK4D	0.630 x 0.984 [16.0 x 25.0]	0.307	0.125	0.995	1.560	0.125
1200.0	511D128M063FR4D	0.709 x 1.417 [18.0 x 36.0]	0.165	0.065	1.690	2.710	0.068
75 WVDC at + 105 °C, SURGE = 90 V							
33.0	511D336M075CC4D	0.394 x 0.512 [10.0 x 13.0]	4.440	1.210	0.153	0.295	1.210
100.0	511D107M075CG4D	0.394 x 0.787 [10.0 x 20.0]	1.460	0.341	0.318	0.661	0.341
150.0	511D157M075DG4D	0.492 x 0.787 [12.5 x 20.0]	1.010	0.261	0.439	0.862	0.261
220.0	511D227M075DK4D	0.492 x 0.984 [12.5 x 25.0]	0.666	0.211	0.589	1.050	0.211
470.0	511D477M075EN4D	0.630 x 1.260 [16.0 x 32.0]	0.307	0.105	1.110	1.880	0.105
100 WVDC at + 105 °C, SURGE = 125 V							
4.7 (1)	511D475M100AA4D	0.236 x 0.433 [6.0 x 11.0]	30.79	4.310	0.041	0.106	4,210
10.0 (1)	511D106M100BB4D	0.314 x 0.472 [8.0 x 12.0]	14.63	1.810	0.071	0.202	1,710
33.0	511D336M100CD4D	0.394 x 0.630 [10.0 x 16.0]	4.440	0.531	0.165	0.477	0.531
120.0	511D127M100DK4D	0.492 x 0.984 [12.5 x 25.0]	1.210	0.215	0.437	1.030	0.215
330.0	511D337M100ER4D	0.630 x 1.260 [16.0 x 32.0]	0.444	0.076	0.958	2.320	0.078
470.0	511D477M100FR4D	0.709 x 1.417 [18.0 x 36.0]	0.361	0.071	1.150	2.610	0.074
160 WVDC at + 105 °C, SURGE = 185 V							
10.0	511D106M160CD4D	0.394 x 0.630 [10.0 x 16.0]	16.09	4.910	0.086	0.157	4.910
22.0	511D226M160DG4D	0.492 x 0.787 [12.5 x 20.0]	7.330	3.210	0.162	0.245	3.210
33.0	511D336M160DK4D	0.492 x 0.984 [12.5 x 25.0]	4.880	2.250	0.216	0.319	2.250
100.0	511D107M160ER4D	0.630 x 1.260 [16.0 x 32.0]	1.610	0.531	0.504	0.876	0.531

Note

(1) These values are normally stocked. See Original Ratings for more values that are stocked.

STANDARD RATINGS in inches [millimeters]							
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR at + 25 °C (mΩ)**		**Max. RIPPLE at + 85 °C**		**Max. IMPEDANCE at + 25 °C (mΩ) 100 Hz**
			120 Hz	**20 kHz - 40 kHz**	**120 Hz**	**20 kHz - 40 kHz**	
200 WVDC at + 105 °C, SURGE = 225 V							
1.5	511D155M200AA4D	0.236 x 0.433 [6.0 x 11.0]	110.01	33.110	0.021	0.038	33.010
22.0	511D226M200DG4D	0.492 x 0.787 [12.5 x 20.0]	7.330	3.210	0.162	0.245	3.210
33.0	511D336M200DK4D	0.492 x 0.984 [12.5 x 25.0]	4.880	2.250	0.216	0.319	2.250
47.0	511D476M200EK4D	0.630 x 0.984 [16.0 x 25.0]	3.384	1.210	0.299	0.501	1.210
120.0	511D127M200FR4D	0.709 x 1.417 [18.0 x 36.0]	1.420	0.481	0.577	0.991	0.491
250 WVDC at + 105 °C, SURGE = 275 V							
10.0	511D106M250CG4D	0.394 x .787 [10.0 x 20.0]	16.090	3.760	0.096	0.198	3.760
33.0	511D336M250EK4D	0.630 x 0.984 [16.0 x 25.0]	4.880	1.270	0.249	0.489	1.270
47.0	511D476M250EN4D	0.630 x 1.260 [16.0 x 32.0]	3.380	0.721	0.331	0.717	0.721

ORIGINAL RATINGS		
CAPACITANCE (µF)	**CASE CODE**	**PART NUMBER**
6.3 WVDC at + 105 °C, SURGE = 8 V		
470.0	CC	511D477M6R3CC4D
1000.0	CG	511D108M6R3CG4D
2200.0	DK	511D228M6R3DK4D
10 WVDC at + 85 °C, SURGE = 13 V		
470.0	CD	511D477M010CD4D
1000.0	DG	511D108M010DG4D
4700.0	ER	511D478M010ER4D
16 WVDC at + 105 °C, SURGE = 20 V		
47.0 (1)	AA	511D476M016AA4D
100.0 (1)	BB	511D107M016BB4D
220.0	CC	511D227M016CC4D
25 WVDC at + 105 °C, SURGE = 32 V		
220.0	CD	511D227M025CD4D
470.0	DG	511D477M025DG4D
1000.0	EK	511D108M025EK4D
35 WVDC at + 105 °C, SURGE = 44 V		
22.0	AA	511D226M035AA4D
47.0	BB	511D476M035BB4D
100.0 (1)	CC	511D107M035CC4D
220.0	CG	511D227M035CG4D
470.0	DK	511D477M035DK4D
1000.0	EN	511D108M035EN4D
50 WVDC at + 105 °C, SURGE = 63 V		
47.0	CC	511D476M050CC4D
220.0	DK	511D227M050DK4D
63 WVDC at + 105 °C, SURGE = 70 V		
10.0 (1)	AA	511D106M063AA4D
22.0	BB	511D226M063BB4D
47.0 (1)	CD	511D476M063CD4D
100.0	CG	511D107M063CG4D
220.0	EK	511D227M063EK4D
470.0	EN	511D477M063EN4D
100 WVDC at + 105 °C, SURGE = 125 V		
22.0	CD	511D226M100CD4D
47.0	CG	511D476M100CG4D
220.0	EN	511D227M100EN4D

Note

(1) These values are normally stocked

Aluminum Capacitors
+ 105 °C, General Purpose Miniature, Radial Lead

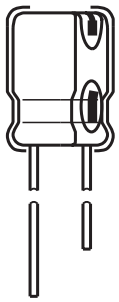


Fig.1 Component outline

FEATURES

- High CV per case size
- Low cost
- Solvent resistant construction (through 100 WVDC)
- High temperature operation
- Life test to 2000 hours at + 105 °C

Pb-free

e3

RoHS COMPLIANT

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.197" x 0.433" [5.0 x 11.0] to 0.709" x 1.575" [18.0 x 40.0]
Operating temperature	- 55 °C to + 105 °C (6.3 WVDC to 100 WVDC) - 40 °C to + 105 °C(160 WVDC to 250 WVDC)
Rated Capacitance range, C_R	0.47 µF to 15 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 250 WVDC
Termination	2 radial leads
Life validation test at 105 °C	2000 hours: Δ CAP ± 20 % from initial measurement. Δ DF 2 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at 105 °C	1000 hours: Δ CAP ± 20 % from initial measurement. Δ DF 2 x initial specified limit. Δ DCL ≤ initial specified limit
DC leakage current	Rated voltage for 1 minute for 6.3 WVDC to 100 WVDC units: I < 0.03 CV or 4 µA (whichever is greater). Rated voltage for 2 minutes for 6.3 WVDC to 100 WVDC units: I < 0.04 CV or 3 µA (whichever is greater). rated voltage for 1 minute for 160 WVDC to 250 WVDC units: I < 0.1 CV + 40 µA and CV > 1000; I < 0.04 CV + 100 µA and CV > 1000

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE	
Ambient Temperature	Multipliers
+ 70 °C	1.78
+ 85 °C	1.4
+ 105 °C	1.0

FREQUENCY (Hz)						
WVDC	Cap. (µF)	50 - 60	100 - 120	300 - 400	1 kHz	≤ 10 kHz
6.3 - 100	0 - 47	0.75	1	1.35	1.57	2.00
	100 - 470	0.80	1	1.23	1.34	1.50
	1000 - 22 000 000	0.85	1	1.10	1.13	1.15
160 - 250	0.47 - 100	0.80	1	1.25	1.40	1.60

LOW TEMPERATURE PERFORMANCE

MAXIMUM IMPEDANCE RATIO $Z^{(T)}/Z^{(+ 20\ °C)}$ MAXIMUM AT 120 Hz

Rated Voltage (WVDC)	Z - 25 °C/Z + 20 °C	Z - 40 °C/Z + 20 °C
6.3	4.0	8.0
10.0	3.0	6.0
16.0	2.0	4.0
25.0 - 100.0	2.0	3.0
160.0 - 200.0	2.0	4.0
250.0	4.0	6.0

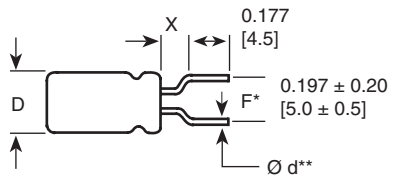
DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL CASE SIZE D x L	LEAD SPACING S	NOMINAL LEAD DIAMETER D	TYPICAL WEIGHT (g)
JA	0.197 x .433 [5.0 x 11.0]	0.079 [2.0]	0.020 [0.50]	0.44
AA	0.248 x .433 [6.3 x 11.0]	0.098 [2.5]	0.020 [0.50]	0.63
BB	0.315 x .453 [8.0 x 11.5]	0.138 [3.5]	0.024 [0.60]	1.03
CC	0.394 x .492 [10.0 x 12.5]	0.197 [5.0]	0.024 [0.60]	1.53
CD	0.394 x .630 [10.0 x 16.0]	0.197 [5.0]	0.024 [0.60]	1.86
CG	0.394 x .787 [10.0 x 20.0]	0.197 [5.0]	0.024 [0.60]	2.48
DG	0.492 x 0.787 [12.5 x 20.0]	0.197 [5.0]	0.024 [0.60]	3.98

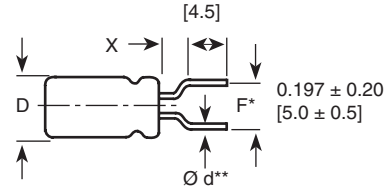
DIMENSIONS in inches [millimeters]				
CASE CODE	**NOMINAL CASE SIZE D x L**	**LEAD SPACING S**	**NOMINAL LEAD DIAMETER D**	**TYPICAL WEIGHT (g)**
DK	0.492 x 0.984 [12.5 x 25.0]	0.197 [5.0]	0.024 [0.60]	5.27
EK	0.630 x 0.984 [16.0 x 25.0]	0.295 [7.5]	0.031 [0.80]	7.72
EN	0.630 x 1.24 [16.0 x 31.5]	0.295 [7.5]	0.031 [0.80]	9.90
ER	0.630 x 1.40 [16.0 x 35.5]	0.295 [7.5]	0.031 [0.80]	11.10
FR	0.709 x 1.40 [18.0 x 35.5]	0.295 [7.5]	0.031 [0.80]	13.04
FV	0.709 x 1.575 [18.0 x 40.0]	0.295 [7.5]	0.031 [0.80]	15.74

ELECTROLYTIC CAPACITOR WITH CUT OR FORMED LEADS in inches [millimeters]

Code F



Code S



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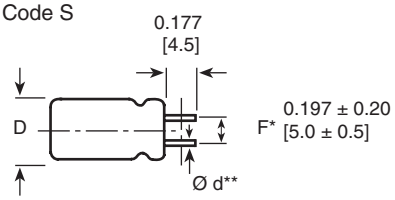
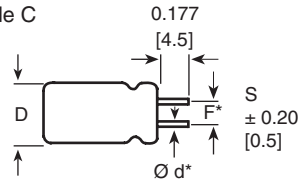


Code C



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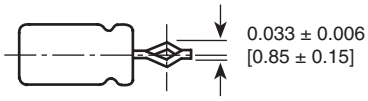
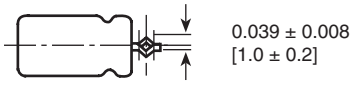


(4, 5, 6.3, 8)

Code S



(10, 12.5, 16, 18)

DIMENSIONS in inches [millimeters]						
FORMING METHOD	**FORMED LEAD CODE**	**DIMENSIONS**				
		D	**L.S.**	**P**	**e*** **	**X (Max.)**
Formed and Cut	F	0.197 [5.0]	0.197 [5.0]	0.079 [2.0]	-	0.059 [1.5]
		0.248 [6.3]	0.197 [5.0]	0.098 [2.5]	-	0.098 [2.5]
		0.315 [8.0]	0.197 [5.0]	0.138 [3.5]	-	0.098 [2.5]
Cut	C	0.394 [10.0]	0.197 [5.0]	-	-	-
		0.492 [12.5]	0.197 [5.0]	-	-	-
		0.630 [16.0]	0.295 [7.5]	-	-	-
		0.709 [18.0]	0.295 [7.5]	-	-	-
Snap-in	S	0.197 [5.0]	0.197 [5.0]	0.079 [2.0]	0.043 [1.1]	0.059 [1.5]
		0.248 [6.3]	0.197 [5.0]	0.098 [2.5]	0.043 [1.1]	0.059 [1.5]
		0.315 [8.0]	0.197 [5.0]	0.138 [3.5]	0.051 [1.3]	0.059 [1.5]
		0.394 [10.0]	0.197 [5.0]	-	0.051 [1.3]	-
		0.492 [12.5]	0.197 [5.0]	-	0.051 [1.3]	-
		0.630 [16.0]	0.295 [7.5]	-	0.051 [1.3]	-
		0.709 [18.0]	0.295 [7.5]	-	0.051 [1.3]	-

Note The ammo pack code is to be added at the end of type number in the 14th and 15th position as 8P. To specify formed, cut or snap-in leads and for tape and ammo, both positions 14 and 15 of the type number must be filled in with the proper codes.

** Except 0.394 [10.0 mm] and 0.492 [12.5 mm] diameter have straight unformed leads.

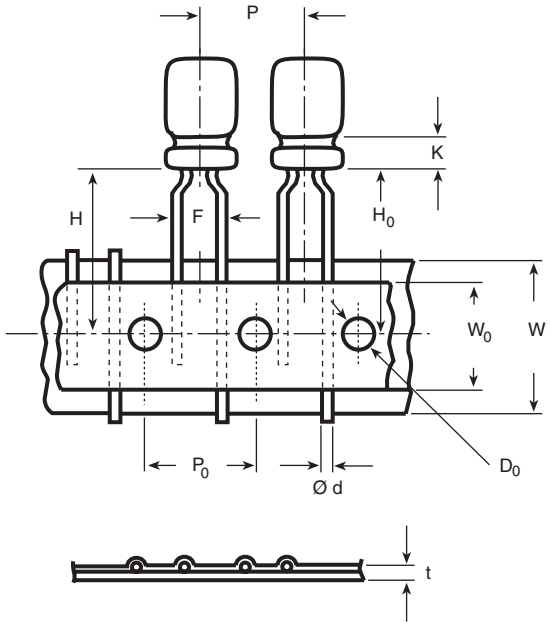
Aluminum Capacitors
+ 105 °C, General Purpose Miniature, Radial Lead

TAPED CAPACITORS FOR AUTOMATIC INSERTION SYSTEMS in inches [millimeters]					
PACKAGING	LEAD CODE 14th AND 15th DIGITS OF PN	SPECIFICATION		LEAD SPACE	CAPACITOR SIZES AVAILABLE
		LEAD STYLE	+ - LEADER		
Ammo Pack	8P	Formed Lead (1)	-	0.197 [5.0]	0.197 x 0.433 [5.0 x 11.0] - 0.492 x 0.787 [4.0 x 7.0 - 12.5 x 20.0]
					Case codes JA, AA, BB, CC, CD, DG

Note The ammo pack code is to be added at the end of type number in the 14th and 15th position as 8P. To specify formed, cut or snap-in leads and for tape and ammo, both positions 14 and 15 of the type number must be filled in with the proper codes.
(1) Except 0.394 [10.0 mm] and 0.492 [12.5 mm] diameter have straight unformed leads.

TAPING SPECIFICATIONS in inches [millimeters]

Formed Lead Type



DIMENSIONS in inches [millimeters]					
ITEM	CASE SIZE (Diameter x Length)				
	FORMED LEAD TYPE			STRAIGHT LEAD TYPE	
	0.197 x 0.433 [5.0 x 11.0]	0.248 x 0.433 [6.3 x 11.0]	0.315 x 0.452 [8.0 x 11.5]	0.394 [10.0] (Dia.)	0.492 [12.5] (Dia.)
Ø d - Lead-wire diameter	0.020 [0.5]	0.020 [0.5]	0.024 [0.6]	0.024 [0.6]	0.024 [0.6]
P - Pitch of component	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.591 [15.0]
P_0 - Feed hole pitch	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.591 [15.0]
F - Lead-to-lead distance	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]
K - Clinch height	0.098 [2.5]	0.098 [2.5]	0.157 [4.0]	-	-
H - Height of component from tape center	0.728 [18.5]	0.728 [18.5]	0.787 [20.0]	0.728 [18.5]	0.630 [16.0]
H_0 - Lead-wire clinch height	0.630 [16.0]	0.630 [16.0]	0.630 [16.0]	-	-
W - Tape width	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0 - Hold down tape width	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]	0.512 [13.0]
D_0 - Feed hole diameter	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]
t - Total tape thickness	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]

Note Coding of cut or formed lead to be added to the end of type number in 15th position (with position 14 coded “6”).
* Formed lead. ** Lead thickness Ø d depends on capacitor specification. *** Lead protrusion at bottom of tape.

ORDERING EXAMPLE

Electrolytic capacitor 517D series: 517D 107M 6R3 JA 6 A E3

DESCRIPTION	
CODE	**EXPLANATION**
517D	product type
107	capacitance value (100 µF)
M	tolerance (M = ± 20 %)
6R3	voltage rating at 85 °C (6R3 = 6.3 V)
JA	can size (see dimensions table)
6	packaging (bulk)
A	lead style (uncut)
E3	RoHS compliant indicator

PACKING AND LEAD STYLES:

6A	Bulk; uncut leads
6C	Bulk; cut leads
6F	Bulk; formed and cut leads
6S	Bulk; snap-in leads
8P	Ammopack, (cases Codes JA, AA, BB, CC, CD, CG, DG only)

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. RIPPLE at + 105 °C 120 Hz (mA)	Max. DF at + 20 °C 120 Hz
6.3 WVDC at + 105 °C, SURGE = 8 V				
22.0	517D226M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	34.0	0.26
33.0	517D336M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	50.0	0.26
47.0	517D476M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	65.0	0.26
100.0	517D107M6R3JA6AE3	0.197 x 0.433 [5.0 x 11.0]	100.0	0.26
220.0	517D227M6R3AA6AE3	0.248 x 0.433 [6.3 x 11.0]	165.0	0.26
330.0	517D337M6R3AA6AE3	0.248 x 0.433 [6.3 x 11.0]	200.0	0.26
470.0	517D477M6R3BB6AE3	0.315 x 0.453 [8.0 x 11.5]	280.0	0.26
1000.0	517D108M6R3CC6AE3	0.394 x 0.492 [10.0 x 12.5]	470.0	0.26
2200.0	517D228M6R3DG6AE3	0.492 x 0.787 [12.5 x 20.0]	930.0	0.26
3300.0	517D338M6R3DG6AE3	0.492 x 0.787 [12.5 x 20.0]	1100.0	0.26
4700.0	517D478M6R3EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1320.0	0.26
6800.0	517D688M6R3EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1490.0	0.26
10 000.0	517D109M6R3EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1830.0	0.26
15 000.0	517D159M6R3FR6AE3	0.709 x 1.398 [18.0 x 35.5]	2280.0	0.26
10 WVDC at + 105 °C, SURGE = 13 V				
22.0	517D226M010JA6AE3	0.197 x 0.433 [5.0 x 11.0]	45.0	0.22
33.0	517D336M010JA6AE3	0.197 x 0.433 [5.0 x 11.0]	60.0	0.22
47.0	517D476M010JA6AE3	0.197 x 0.433 [5.0 x 11.0]	75.0	0.22
100.0	517D107M010JA6AE3	0.197 x 0.433 [5.0 x 11.0]	110.0	0.22
220.0	517D227M010AA6AE3	0.248 x 0.433 [6.3 x 11.0]	180.0	0.22
330.0	517D337M010BB6AE3	0.315 x 0.453 [8.0 x 11.5]	255.0	0.22
470.0	517D477M010BB6AE3	0.315 x 0.453 [8.0 x 11.5]	305.0	0.22
1000.0	517D108M010CD6AE3	0.394 x 0.630 [10.0 x 16.0]	570.0	0.22
2200.0	517D228M010DG6AE3	0.492 x 0.787 [12.5 x 20.0]	1010.0	0.22
3300.0	517D338M010DK6AE3	0.492 x 0.984 [12.5 x 25.0]	1220.0	0.22
4700.0	517D478M010EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1410.0	0.22
6800.0	517D688M010EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1610.0	0.22
10 000.0	517D109M010FR6AE3	0.709 x 1.398 [18.0 x 35.5]	1980.0	0.22
15 000.0	517D159M010FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2470.0	0.22

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. RIPPLE at + 105 °C 120 Hz (mA)	Max. DF at + 20 °C 120 Hz
16 WVDC at + 105 °C, SURGE = 20 V				
10.0	517D106M016JA6AE3	0.197 x 0.433 [5.0 x 11.0]	35.0	0.18
22.0	517D226M016JA6AE3	0.197 x 0.433 [5.0 x 11.0]	55.0	0.18
33.0	517D336M016JA6AE3	0.197 x 0.433 [5.0 x 11.0]	70.0	0.18
47.0	517D476M016JA6AE3	0.197 x 0.433 [5.0 x 11.0]	85.0	0.18
100.0	517D107M016AA6AE3	0.248 x 0.433 [6.3 x 11.0]	135.0	0.18
220.0	517D227M016BB6AE3	0.315 x 0.453 [8.0 x 11.5]	235.0	0.18
330.0	517D337M016BB6AE3	0.315 x 0.453 [8.0 x 11.5]	285.0	0.18
470.0	517D477M016CC6AE3	0.394 x .0492 [10.0 x 12.5]	395.0	0.18
1000.0	517D108M016CG6AE3	0.394 x 0.787 [10.0 x 20.0]	700.0	0.18
2200.0	517D228M016DK6AE3	0.492 x 0.984 [12.5 x 25.0]	1150.0	0.18
3300.0	517D338M016EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1350.0	0.18
4700.0	517D478M016EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1560.0	0.18
6800.0	517D688M016FR6AE3	0.709 x 1.398 [18.0 x 35.5]	1750.0	0.18
10 000.0	517D109M016FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2170.0	0.18
25 WVDC at + 105 °C, SURGE = 32 V				
4.7	517D475M025JA6AE3	0.197 x .0433 [5.0 x 11.0]	24.0	0.16
10.0	517D106M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	39.0	0.16
22.0	517D226M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	60.0	0.16
33.0	517D336M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	75.0	0.16
47.0	517D476M025JA6AE3	0.197 x 0.433 [5.0 x 11.0]	90.0	0.16
100.0	517D107M025AA6AE3	0.248 x 0.433 [6.3 x 11.0]	145.0	0.16
220.0	517D227M025BB6AE3	0.315 x 0.453 [8.0 x 11.5]	250.0	0.16
330.0	517D337M025CC6AE3	0.394 x 0.492 [10.0 x 12.5]	355.0	0.16
470.0	517D477M025CD6AE3	0.394 x 0.630 [10.0 x 16.0]	470.0	0.16
1000.0	517D108M025DG6AE3	0.492 x 0.787 [12.5 x 20.0]	855.0	0.16
2200.0	517D228M025EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1230.0	0.16
3300.0	517D338M025EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1450.0	0.16
4700.0	517D478M025FR6AE3	0.709 x 1.398 [18.0 x 35.5]	1660.0	0.16
35 WVDC at + 105 °C, SURGE = 44 V				
4.7	517D475M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	27.0	0.13
10.0	517D106M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	44.0	0.13
22.0	517D226M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	65.0	0.13
33.0	517D336M035JA6AE3	0.197 x 0.433 [5.0 x 11.0]	85.0	0.13
47.0	517D476M035AA6AE3	0.248 x 0.433 [6.3 x 11.0]	115.0	0.13
100.0	517D107M035BB6AE3	0.315 x 0.453 [8.0 x 11.5]	190.0	0.13
220.0	517D227M035CC6AE3	0.394 x 0.492 [10.0 x 12.5]	325.0	0.13
330.0	517D337M035CD6AE3	0.394 x 0.630 [10.0 x 16.0]	440.0	0.13
470.0	517D477M035CG6AE3	0.394 x 0.787 [10.0 x 20.0]	580.0	0.13
1000.0	517D108M035DK6AE3	0.492 x 0.984 [12.5 x 25.0]	995.0	0.13
2200.0	517D228M035EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1450.0	0.13
3300.0	517D338M035FR6AE3	0.709 x 1.398 [18.0 x 35.5]	1660.0	0.13
4700.0	517D478M035FV6AE3	0.709 x 1.575 [18.0 x 40.0]	2030.0	0.13

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. RIPPLE at + 105 °C 120 Hz (mA)	Max. DF at + 20 °C 120 Hz
50 WVDC at + 105 °C, SURGE = 63 V				
0.47	517D474M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	7.0	0.10
1.0	517D105M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	12.0	0.10
2.2	517D225M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	18.0	0.10
3.3	517D335M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	25.0	0.10
4.7	517D475M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	30.0	0.10
10.0	517D106M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	50.0	0.10
22.0	517D226M050JA6AE3	0.197 x 0.433 [5.0 x 11.0]	75.0	0.10
33.0	517D336M050M6AE3	0.248 x 0.433 [6.3 x 11.0]	105.0	0.10
47.0	517D476M050AA6AE3	0.248 x 0.433 [6.3 x 11.0]	125.0	0.10
100.0	517D107M050BB6AE3	0.315 x 0.453 [8.0 x 11.5]	210.0	0.10
220.0	517D227M050CD6AE3	0.394 x 0.630 [10.0 x 16.0]	400.0	0.10
330.0	517D337M050CG6AE3	0.394 x 0.787 [10.0 x 20.0]	535.0	0.10
470.0	517D477M050DG6AE3	0.492 x 0.787 [12.5 x 20.0]	730.0	0.10
1000.0	517D108M050EK6AE3	0.630 x 0.984 [16.0 x 25.0]	1110.0	0.10
2200.0	517D228M050FR6AE3	0.709 x 1.398 [18.0 x 35.5]	1530.0	0.10
63 WVDC at + 105 °C, SURGE = 79 V				
4.7	517D475M063JA6AE3	0.197 x 0.433 [5.0 x 11.0]	34.0	0.09
10.0	517D106M063JA6AE3	0.197 x 0.433 [5.0 x 11.0]	55.0	0.09
22.0	517D226M063AA6AE3	0.248 x 0.433 [6.3 x 11.0]	90.0	0.09
33.0	517D336M063AA6AE3	0.248 x 0.433 [6.3 x 11.0]	110.0	0.09
47.0	517D476M063BB6AE3	0.315 x 0.453 [8.0 x 11.5]	155.0	0.09
100.0	517D107M063CC6AE3	0.394 x .0492 [10.0 x 12.5]	260.0	0.09
220.0	517D227M063CG6AE3	0.394 x 0.787 [10.0 x 20.0]	465.0	0.09
330.0	517D337M063DG6AE3	0.492 x 0.787 [12.5 x 20.0]	650.0	0.09
4700.0	517D477M063DK6AE3	0.492 x 0.984 [12.5 x 25.0]	800.0	0.09
1000.0	517D108M063EN6AE3	0.630 x 1.240 [16.0 x 31.5]	1200.0	0.09
2200.0	517D228M063FV6AE3	0.709 x 1.575 [18.0 x 40.0]	1840.0	0.09
100 WVDC at + 105 °C, SURGE = 125 V				
0.47	517D474M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	10.0	0.08
1.0	517D105M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	15.0	0.08
2.2	517D225M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	22.0	0.08
3.3	517D335M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	29.0	0.08
4.7	517D475M100JA6AE3	0.197 x 0.433 [5.0 x 11.0]	37.0	0.08
10.0	517D106M100AA6AE3	0.248 x 0.433 [6.3 x 11.0]	65.0	0.08
22.0	517D226M100BB6AE3	0.315 x 0.453 [8.0 x 11.5]	115.0	0.08
33.0	517D336M100CC6AE3	0.394 x 0.492 [10.0 x 12.5]	160.0	0.08
47.0	517D476M100CD6AE3	0.394 x 0.630 [10.0 x 16.0]	220.0	0.08
100.0	517D107M100DG6AE3	0.492 x 0.787 [12.5 x 20.0]	385.0	0.08
220.0	517D227M100EK6AE3	0.630 x 0.984 [16.0 x 25.0]	590.0	0.08
330.0	517D337M100EK6AE3	0.630 x 0.984 [16.0 x 25.0]	720.0	0.08
470.0	517D477M100EN6AE3	0.630 x 1.240 [16.0 x 31.5]	875.0	0.08
1000.0	517D108M100FV6AE3	0.709 x 1.575 [18.0 x 40.0]	1320.0	0.08

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. RIPPLE at + 105 °C 120 Hz (mA)	Max. DF at + 20 °C 120 Hz
160 WVDC at + 105 °C, SURGE = 200 V				
0.47	517D474M160AA6AE3	0.248 x 0.433 [6.3 x 11.0]	12.0	0.15
1.0	517D105M160AA6AE3	0.248 x 0.433 [6.3 x 11.0]	17.0	0.15
2.2	517D225M160AA6AE3	0.248 x 0.433 [6.3 x 11.0]	25.0	0.15
3.3	517D335M160BB6AE3	0.315 x 0.453 [8.0 x 11.5]	36.0	0.15
4.7	517D475M160BB6AE3	0.315 x 0.453 [8.0 x 11.5]	43.0	0.15
10.0	517D106M160CC6AE3	0.394 x 0.492 [10.0 x 12.5]	70.0	0.15
22.0	517D226M160CG6AE3	0.394 x 0.787 [10.0 x 20.0]	130.0	0.15
33.0	517D336M160DG6AE3	0.492 x 0.787 [12.5 x 20.0]	180.0	0.15
47.0	517D476M160DK6AE3	0.492 x 0.984 [12.5 x 25.0]	220.0	0.15
100.0	517D107M160EK6AE3	0.630 x 0.984 [16.0 x 25.0]	330.0	0.15
220.0	517D227M160FR6AE3	0.709 x 1.398 [18.0 x 35.5]	500.0	0.15
200 WVDC at + 105 °C, SURGE = 250 V				
0.47	517D474M200AA6AE3	0.248 x 0.433 [6.3 x 11.0]	12.0	0.15
1.0	517D105M200AA6AE3	0.248 x 0.433 [6.3 x 11.0]	17.0	0.15
2.2	517D225M200AA6AE3	0.248 x 0.433 [6.3 x 11.0]	25.0	0.15
3.3	517D335M200BB6AE3	0.315 x 0.453 [8.0 x 11.5]	36.0	0.15
4.7	517D475M200CC6AE3	0.394 x 0.492 [10.0 x 12.5]	50.0	0.15
10.0	517D106M200CD6AE3	0.394 x 0.630 [10.0 x 16.0]	80.0	0.15
22.0	517D226M200CG6AE3	0.394 x 0.787 [10.0 x 20.0]	140.0	0.15
33.0	517D336M200DK6AE3	0.492 x 0.984 [12.5 x 25.0]	198.0	0.15
47.0	517D476M200DK6AE3	0.492 x 0.984 [12.5 x 25.0]	220.0	0.15
100.0	517D107M200EN6AE3	0.630 x 1.240 [16.0 x 31.5]	335.0	0.15
220.0	517D227M200FV6AE3	0.709 x 1.575 [18.0 x 40.0]	515.0	0.15
250 WVDC at + 105 °C, SURGE = 300 V				
0.47	517D474M250AA6AE3	0.248 x 0.433 [6.3 x 11.0]	12.0	0.15
1.0	517D105M250AA6AE3	0.248 x 0.433 [6.3 x 11.0]	17.0	0.15
2.2	517D225M250BB6AE3	0.315 x 0.453 [8.0 x 11.5]	29.0	0.15
3.3	517D335M250CC6AE3	0.394 x 0.492 [10.0 x 12.5]	42.0	0.15
4.7	517D475M250CC6AE3	0.394 x 0.492 [10.0 x 12.5]	50.0	0.15
10.0	517D106M250CG6AE3	0.394 x 0.787 [10.0 x 20.0]	88.0	0.15
22.0	517D226M250DK6AE3	0.492 x 0.984 [12.5 x 25.0]	155.0	0.15
33.0	517D336M250DK6AE3	0.492 x 0.984 [12.5 x 25.0]	190.0	0.15
47.0	517D476M250EK6AE3	0.630 x 0.984 [16.0 x 25.0]	230.0	0.15
100.0	517D107M250FR6AE3	0.709 x 1.398 [18.0 x 35.5]	340.0	0.15

Aluminum Capacitors
+ 105 °C, Miniature, Radial Lead

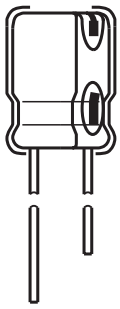


Fig.1 Component outline

FEATURES

- Improved SMPS output capacitors
- Highest ripple current ratings per case size
- High CV

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.394" x 0.472" [10.0 x 12.0] to 0.709" x 1.575" [18.0 x 40.0]
Operating temperature	- 55 °C to + 105 °C
Rated Capacitance range, C_R	33 µF to 6800 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 63 WVDC
Termination	2 and 3 radial leads and axial mount.
Life validation test at 105 °C	4000 hours (≥ 0.512" [13.0] diameter): 3000 hours (0.394" [10.0] diameter): Δ CAP ≤ 20 % (6.3 WVDC to 25 WVDC), ≤ 15 % (40 WVDC to 63 WVDC) from initial measurement. Δ ESR ≤ 1.3 x initial specified limit. Δ DCL ≤ 2 x initial specified limit.
Shelf life at 105 °C	1000 hours: Δ CAP ≤ 20 % (6.3 WVDC to 25 WVDC), ≤ 15 % (40 WVDC to 63 WVDC) from initial measurements. Δ ESR ≤ 1.3 x initial specified limit.
DC leakage current	I = 0.01 CV, 2 minute charge time. I = 0.03 CV, 1 minute charge time. I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE	
AMBIENT TEMPERATURE	MULTIPLIERS
+ 105 °C	1.0
+ 85 °C	2.2
+ 75 °C	2.7
≤ + 65 °C	3.0

FREQUENCY (Hz)					
WVDC	50 - 60	100 - 120	300 - 400	1 k - 19 k	20 k to 200 k
6.3 - 63	0.60	0.70	0.75	0.82	1.0

LOW TEMPERATURE PERFORMANCE

CAPACITANCE RATIO $C^{-55\,°C}/C^{+25\,°C}$ MINIMUM AT 120 Hz		
Maximum Capacitance Change	Voltage	Multiplier
	6.3 V - 16 V	0.75
	25 V- 63 V	0.85
Maximum Impedance Change	Voltage	Multiplier
	6.3 V - 16 V	2.0
	25 V - 63 V	1.5

ESL (TYPICAL VALUES AT 1 MHz TO 10 MHz)				
Nominal Diameter	0.394 [10.0]	0.512 [13.0]	0.630 [18.0]	0.709 [18.0]
Typical ESL (nH)	4.0	7.0	10.0	12.0

DIMENSIONS in inches [millimeters]

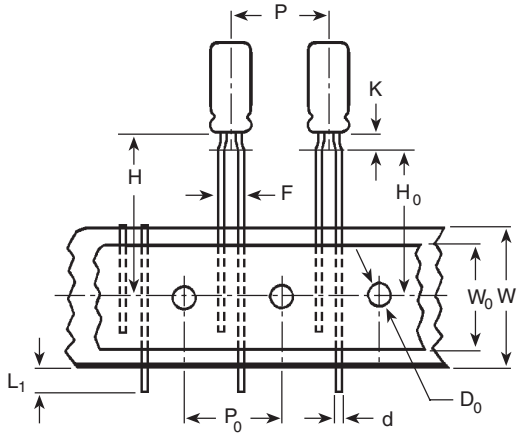
CASE CODE	NOMINAL		STYLES 2 AND 4		STYLES 3 AND 5		LEAD SPACING		LEAD DIAMETER	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.024 [0.60]		Nominal	AWG No.
CC	0.394 [10.0]	0.512 [13.0]	0.413 [10.5]	0.563 [14.3]	0.413 [10.5]	0.630 [16.0]	0.197 [5.0]		0.025 [0.63]	22
CD	0.394 [10.0]	0.630 [16.0]	0.413 [10.5]	0.669 [17.0]	0.413 [10.5]	0.740 [18.8]	0.197 [5.0]		0.025 [0.63]	22
CG	0.394 [10.0]	0.787 [20.0]	0.413 [10.5]	0.846 [21.5]	0.413 [10.5]	0.906 [23.0]	0.197 [5.0]		0.025 [0.63]	22
DG	0.49 [12.5]	0.787 [20.0]	0.512 [13.0]	0.846 [21.5]	0.512 [13.0]	0.906 [23.0]	0.197 [5.0]		0.032 [0.81]	20
DK	0.492 [12.5]	0.984 [25.0]	0.512 [13.0]	1.043 [26.5]	0.512 [13.0]	1.142 [29.0]	0.197 [5.0]		0.032 [0.81]	20
CASE CODE	NOMINAL		STYLES 2 AND 4		STYLES 3 AND 5		LEAD SPACING		LEAD DIAMETER	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.002 [0.50]	T ± 0.002 [0.50]	Nominal	AWG No.
DM	0.492 [12.5]	1.043 [26.5]	0.512 [13.0]	1.102 [28.0]	0.512 [13.0]	1.161 [29.5]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
DT	0.492 [12.5]	1.319 [33.5]	0.512 [13.0]	1.346 [34.2]	0.512 [13.0]	1.417 [36.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
DS	0.492 [12.5]	1.673 [42.5]	0.512 [13.0]	1.720 [43.7]	0.512 [13.0]	1.791 [45.5]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
EK	0.630 [16.0]	0.984 [25.0]	0.650 [16.5]	1.031 [26.2]	0.650 [16.5]	1.098 [27.9]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20

Aluminum Capacitors
+ 105 °C, Miniature, Radial Lead

DIMENSIONS in inches [millimeters]										
CASE CODE	NOMINAL		STYLES 2 AND 4		STYLES 3 AND 5		LEAD SPACING		LEAD DIAMETER	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.002 [0.50]	T ± 0.002 [0.50]	Nominal	AWG No.
EN	0.630 [16.0]	1.260 [32.0]	0.650 [16.5]	1.319 [33.5]	0.650 [16.5]	1.417 [36.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
ER	0.630 [16.0]	1.417 [36.0]	0.650 [16.5]	1.476 [37.5]	0.650 [16.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
EU	0.630 [16.0]	1.575 [40.0]	0.650 [16.5]	1.642 [41.7]	0.65 [16.5]	1.669 [42.4]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
FR	0.709 [18.0]	1.417 [36.0]	0.728 [18.5]	1.476 [37.5]	0.728 [18.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
FV	0.709 [18.0]	1.57 [40.0]	0.728 [18.5]	1.654 [42.0]	0.728 [18.5]	1.693 [43.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20

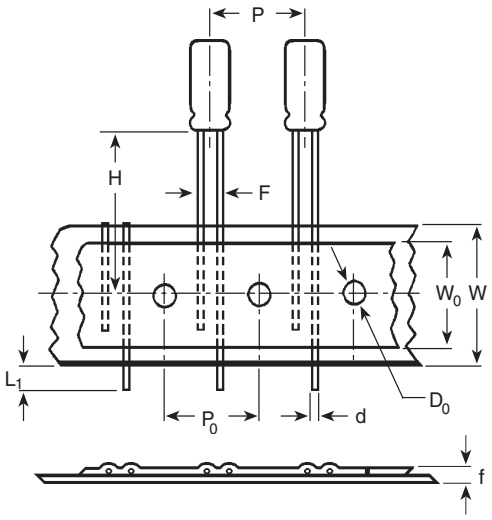
TAPE AND REEL, SPECIFICATIONS TO EIA-468D in inches [millimeters]

Formed Leads



DIMENSIONS in inches [millimeters] **AND PACKAGING QUANTITIES**		
CASE SIZE	F LEAD SPACING	STD. QTY/REEL
0.236 x 0.453 [6.0 x 11.0]	0.197 [5.0]	800
0.315 x 0.472 [8.0 x 12.0]	0.197 [5.0]	700

Unformed (Straight) Leads



DIMENSIONS in inches [millimeters] **AND PACKAGING QUANTITIES**		
CASE SIZE	F LEAD SPACING	STD. QTY/REEL
0.236 x 0.453 [6.0 x 11.0]	0.098 [2.5]	800
0.315 x 0.472 [8.0 x 12.0]	0.140 (1) [3.5]	700
0.394 x 0.512 [10.0 x 13.0]	0.197 [5.0]	500
0.394 x 0.630 [10.0 x 16.0]	0.197 [5.0]	500
0.394 x 0.787 [10.0 x 20.0]	0.197 [5.0]	500

Note (1) Available as special order.

DIMENSIONS in inches [millimeters]					
ITEM	CASE SIZE (Diameter x Length)				
	0.236 x 0.433 [6.0 x 11.0]	0.315 x 0.472 [8.0 x 12.0]	0.394 x 0.512 [10.0 x 13.0]	0.394 x 0.630 [10.0 x 16.0]	0.394 x 0.787 [10.0 x 20.0]
d - Lead-wire diameter	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]
P - Pitch of component	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
P_0 - Feed hole pitch	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
F - Lead-to-lead distance	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]
K - Clinch height	0.098 [2.5]	0.157 [4.0]	N/A	N/A	N/A
H - Height of component from tape center	0.728 [18.5]	0.787 [20.0]	0.906 [23.0]	0.906 [23.0]	0.906 [23.0]
H_0 - Lead-wire clinch height	0.630 [16.0]	0.630 [16.0]	N/A	N/A	N/A
W - Tape width	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0 - Hold down tape width	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]
D_0 - Feed hole diameter	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]
t - Totaltape thickness	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]
L1 -Maximumlead protrusion	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]

Note Terminal Code "l" = Tape and reel. Terminal Code "+" = Tape and ammo.
Positive leader is standard. Negative leader is available by special order.

ORDERING EXAMPLE

Electrolytic capacitor 678D series: 678D 108 M 6R3 DG 3 D

DESCRIPTION	
CODE	EXPLANATION
678D	product type
108	capacitance value (1000 µF)
M	tolerance (M = ± 20 %)
6R3	voltage rating at 105 °C (6R3 = 6.3 V)
DG	can size (see dimensions table)
3	sleeve and sealing (3 = p.v.c. sleeve w/epoxy end seal)
D	packaging (D = bulk; straight leads)

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. ESR at + 25 °C (mΩ)		Max. RIPPLE at + 105 °C (A)	Max. IMPEDANCE at + 25 °C (mΩ)
			20 Hz	20 kHz	20 kHz - 100 kHz	100 Hz
6.3 WVDC at 105 °C, SURGE = 9 V						
330.0	678D337M6R3CC3D	0.394 x 0.512 [10.0 x 13.0]	0.540	0.213	0.36	0.213
470.0	678D477M6R3CD3D	0.394 x 0.630 [10.0 x 16.0]	0.340	0.133	0.49	0.132
1000.0	678D108M6R3DG3D	0.492 x 0.787 [12.5 x 20.0]	0.200	0.071	0.83	0.070
2200.0	678D228M6R3EK3D	0.630 x 0.984 [16.0 x 25.0]	0.110	0.041	1.36	0.045
3300.0	678D338M6R3DS3D	0.492 x 1.673 [12.5 x 42.5]	0.067	0.031	1.67	0.032
4700.0	678D478M6R3FR3D	0.709 x 1.417 [18.0 x 36.0]	0.066	0.029	2.02	0.031
10 WVDC at 105 °C, SURGE = 13 V						
330.0	678D337M010CD3D	0.394 x 0.630 [10.0 x 16.0]	0.350	0.135	0.46	0.134
470.0	678D477M010CG3D	0.394 x 0.787 [10.0 x 20.0]	0.235	0.092	0.63	0.090
1000.0 (1)	678D108M010DM3D	0.492 x 1.043 [12.5 x 26.5]	0.120	0.062	0.98	0.061
2200.0	678D228M010EK3D	0.630 x 0.984 [16.0 x 25.0]	0.115	0.042	1.52	0.046
3300.0	678D338M010EN3D	0.630 x 1.260 [16.0 x 32.0]	0.085	0.038	1.56	0.041
4700.0	678D487M010FR3D	0.709 x 1.417 [18.0 x 36.0]	0.070	0.031	1.97	0.033

Note
(1) These values are normally stocked.

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR at + 25 °C (mΩ)**		**Max. RIPPLE at + 105 °C (A)**	**Max. IMPEDANCE at + 25 °C (mΩ) 100 Hz**
			20 Hz	**20 kHz**	**20 kHz - 100 kHz**	
16 WVDC at 105 °C, SURGE = 20 V						
220.0 (1)	678D227M016CC3D	0.394 x 0.512 [10.0 x 13.0]	0.585	0.217	0.40	0.217
330.0 (1)	678D337M016CD3D	0.394 x 0.630 [10.0 x 16.0]	0.370	0.137	0.52	0.136
470.0	678D477M016CG3D	0.394 x 0.787 [10.0 x 20.0]	0.250	0.098	0.70	0.094
1000.0 (1)	678D108M016DM3D	0.492 x 1.043 [12.5 x 26.5]	0.130	0.066	1.00	0.065
2200.0	678D228M016ER3D	0.630 x 1.417 [16.0 x 36.0]	0.074	0.032	1.78	0.034
3300.0	678D338M016FR3D	0.709 x 1.417 [18.0 x 36.0]	0.074	0.032	1.94	0.034
20 WVDC at 105 °C, SURGE = 30 V						
220.0	678D227M020CD3D	0.394 x 0.630 [10.0 x 16.0]	0.380	0.150	0.41	0.148
330.0	678D337M020CG3D	0.394 x 0.787 [10.0 x 20.0]	0.270	0.100	0.61	0.098
470.0	678D477M020DG3D	0.492 x 0.787 [12.5 x 20.0]	0.250	0.077	0.45	0.075
1000.0	678D108M020DT3D	0.492 x 1.280 [12.5 x 33.5]	0.115	0.048	0.78	0.045
2200.0	678D228M020ER3D	0.630 x 1.417 [16.0 x 36.0]	0.077	0.032	1.80	0.034
3300.0	678D338M020FV3D	0.709 x 1.575 [18.0 x 40.0]	0.061	0.026	2.25	0.028
25 WVDC at 105 °C, SURGE = 35 V						
100.0 (1)	678D107M025CC3D	0.394 x 0.512 [10.0 x 13.0]	0.700	0.250	0.32	0.250
220.0	678D227M025CG3D	0.394 x 0.787 [10.0 x 20.0]	0.300	0.105	0.59	0.100
330.0 (1)	678D337M025DG3D	0.492 x 0.787 [12.5 x 20.0]	0.270	0.078	0.79	0.076
470.0 (1)	678D477M025DM3D	0.492 x 1.043 [12.5 x 26.5]	0.160	0.067	0.97	0.068
1000.0	678D108M025DS3D	0.492 x 1.673 [12.5 x 42.5]	0.090	0.034	1.60	0.036
2200.0	678D228M025FV3D	0.709 x 1.575 [18.0 x 40.0]	0.062	0.026	2.22	0.028
40 WVDC at 105 °C, SURGE = 55 V						
47.0	678D476M040CC3D	0.394 x 0.512 [10.0 x 13.0]	0.950	0.265	0.28	0.265
100.0 (1)	678D107M040CD3D	0.394 x 0.630 [10.0 x 16.0]	0.580	0.165	0.38	0.165
330.0 (1)	678D337M040DM3D	0.492 x 1.043 [12.5 x 26.5]	0.200	0.068	0.93	0.070
470.0 (1)	678D477M040EK3D	0.630 x 0.984 [16.0 x 25.0]	0.133	0.046	1.28	0.050
1000.0	678D108M040ER3D	0.630 x 1.417 [16.0 x 36.0]	0.080	0.033	1.76	0.035
50 WVDC at 105 °C, SURGE = 75 V						
47.0	678D476M050CC3D	0.394 x 0.512 [10.0 x 13.0]	1.250	0.275	0.28	0.275
100.0 (1)	678D107M050CG3D	0.394 x 0.787 [10.0 x 20.0]	0.520	0.115	0.57	0.112
220.0	678D227M050DM3D	0.472 x 1.043 [12.5 x 26.5]	0.240	0.069	0.93	0.071
330.0	678D337M050EK3D	0.630 x 0.984 [16.0 x 25.0]	0.150	0.048	1.26	0.052
470.0	678D477M050DS3D	0.492 x 1.673 [12.5 x 42.5]	0.110	0.036	1.55	0.039
1000.0	678D108M050FV3D	0.709 x 1.575 [18.0 x 40.0]	0.077	0.028	2.15	0.032
63 WVDC at 105 °C, SURGE = 80 V						
33.0	678D336M063CC3D	0.394 x 0.512 [10.0 x 13.0]	1.600	0.288	0.27	0.288
47.0	678D476M063CD3D	0.394 x 0.630 [10.0 x 16.0]	1.000	0.180	0.37	0.180
100.0	678D107M063DG3D	0.492 x 0.787 [12.5 x 20.0]	0.450	0.093	0.72	0.090
220.0	678D227M063DT3D	0.492 x 1.280 [12.5 x 33.5]	0.160	0.055	1.10	0.054
220.0 (1)	678D227M063EK3D	0.630 x 0.984 [16.0 x 25.0]	0.170	0.050	1.23	0.054
330.0	678D337M063DS3D	0.492 x 1.673 [12.5 x 42.5]	0.130	0.038	1.51	0.040
470.0	678D477M063ER3D	0.630 x 1.417 [16.0 x 36.0]	0.120	0.035	1.70	0.038

Note
(1) These values are normally stocked.

Aluminum Capacitors
+ 105 °C, Miniature, Radial Lead

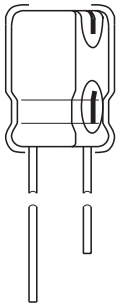


Fig.1 Component outline

FEATURES

- Low impedance
- Low ESR
- High ripple current capability
- High capacitance
- Long life and stability

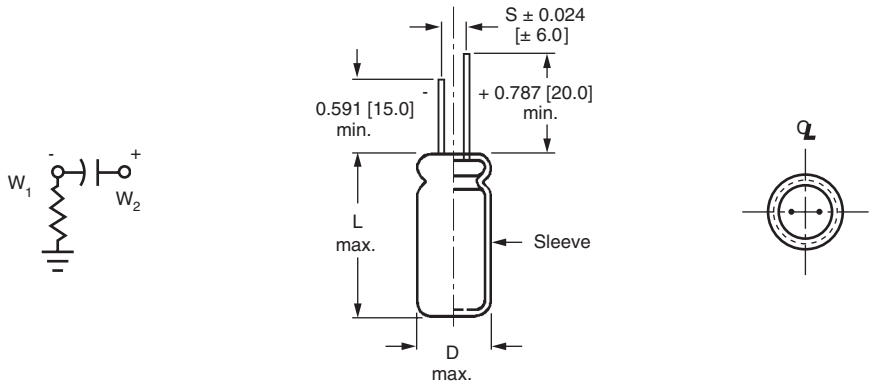
QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	0.315" x 0.472" [8.0 x 12.0] to 0.709" x 1.575" [18.0 x 40.0]
Operating temperature	- 55 °C to + 105 °C
Rated capacitance range, C_R	120 µF to 15 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 35 WVDC
Termination	2 and 3 radial leads and axial mount
Life validation test at 105 °C	5000 hours: Δ CAP ≤ 20 % from initial measurement. Δ ESR ≤ 1.25 x initial specified limit. Δ DCL ≤ initial specified limit. Δ Z ≤1.75 x initial measurement.
Shelf life at 105 °C	1000 hours: Δ CAP ≤ 15 % from initial measurement. Δ ESR ≤ 1.10 x initial specified limit. Δ DCL ≤ initial specified limit.
DC leakage current at 25 °C	I = 0.01 CV, 2 minutes charge time I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS			
TEMPERATURE			
Ambient temperature	**Multipliers**		
+ 105 °C	1.0		
+ 85 °C	1.73		
+ 65 °C	2.23		
+ 45 °C	2.64		
+ 25 °C	3.0		
FREQUENCY (Hz)			
WVDC	**400**	**1K - 19K**	**20K - 200K**
6.3 - 35	0.75	0.82	1.0

LOW TEMPERATURE PERFORMANCE		
CAPACITANCE RATIO C $^{-55\ °C}$/C $^{+25\ °C}$ MINIMUM AT 120 Hz		
MAXIMUM CAPACITANCE CHANGE		
Voltage	**Multiplier**	
6.3 V - 35 V	0.75	
MAXIMUM IMPEDANCE CHANGE		
Voltage	**120 kHz**	**20 kHz - 100 kHz**
6.3 V - 35 V	4	40

DIMENSIONAL CONFIGURATIONS in inches [millimeters]

Terminal Code D

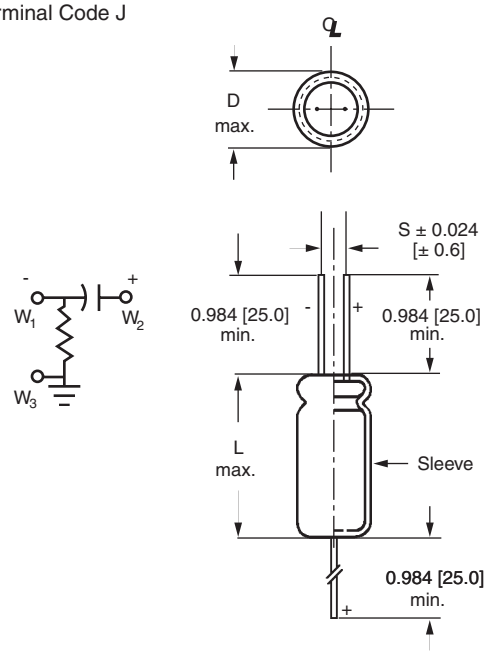


For technical questions, contact: aluminumcaps4@vishay.com

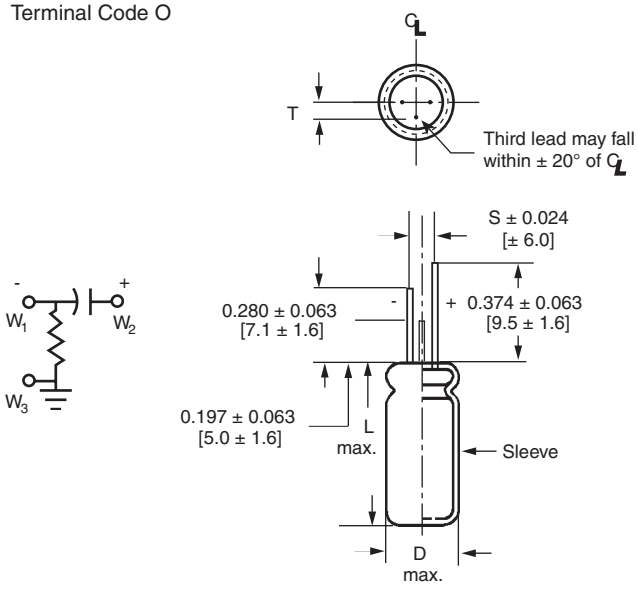
Aluminum Capacitors
+ 105 °C, Miniature, Radial Lead

DIMENSIONS in inches [millimeters]											
CASE CODE	NOMINAL		STYLE 4		STYLE 3		LEAD SPACING		LEAD DIAMETER		TYPICAL WEIGHT (g)
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.024 [0.60]	T ± 0.020 [0.50]	Nominal	AWG No.	
BB	0.315 [8.0]	0.472 [12.0]	0.335 [8.5]	0.512 [13.0]	0.335 [8.5]	0.551 [14.0]	0.138 [3.5]	N/A	0.025 [0.63]	22	1.0
CC	0.394 [10.0]	0.512 [13.0]	0.413 [10.5]	0.563 [14.3]	0.413 [10.5]	0.630 [16.0]	0.197 [5.0]	N/A	0.025 [0.63]	22	1.7
CD	0.394 [10.0]	0.630 [16.0]	0.413 [10.5]	0.670 [17.0]	0.413 [10.5]	0.740 [18.8]	0.197 [5.0]	N/A	0.025 [0.63]	22	2.0
CG	0.394 [10.0]	0.787 [20.0]	0.413 [10.5]	0.846 [21.5]	0.413 [10.5]	0.906 [23.0]	0.197 [5.0]	N/A	0.025 [0.63]	22	2.5
DG	0.492 [12.5]	0.787 [20.0]	0.512 [13.0]	0.846 [21.5]	0.512 [13.0]	0.906 [23.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20	3.8
DK	0.492 [12.5]	0.984 [25.0]	0.512 [13.0]	1.043 [26.5]	0.512 [13.0]	1.142 [29.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20	4.5
DT	0.492 [12.5]	1.319 [33.5]	0.512 [13.0]	1.346 [34.2]	0.512 [13.0]	1.417 [36.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20	5.8
DS	0.492 [12.5]	1.673 [42.5]	0.512 [13.0]	1.720 [43.7]	0.512 [13.0]	1.791 [45.5]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20	7.3
EK	0.630 [16.0]	0.984 [25.0]	0.650 [16.5]	1.031 [26.2]	0.650 [16.5]	1.098 [27.9]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20	7.2
EN	0.630 [16.0]	1.260 [32.0]	0.650 [16.5]	1.319 [33.5]	0.650 [16.5]	1.417 [36.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20	9.4
ER	0.630 [16.0]	1.417 [36.0]	0.650 [16.5]	1.476 [37.5]	0.650 [16.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20	10.6
EU	0.630 [16.0]	1.575 [40.0]	0.650 [16.5]	1.642 [41.7]	0.650 [16.5]	1.669 [42.4]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20	11.8
FR	0.709 [18.0]	1.417 [36.0]	0.728 [18.5]	1.476 [37.5]	0.728 [18.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20	13.4
FV	0.709 [18.0]	1.575 [40.0]	0.728 [18.5]	1.654 [42.0]	0.728 [18.5]	1.693 [43.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20	14.9

Terminal Code J

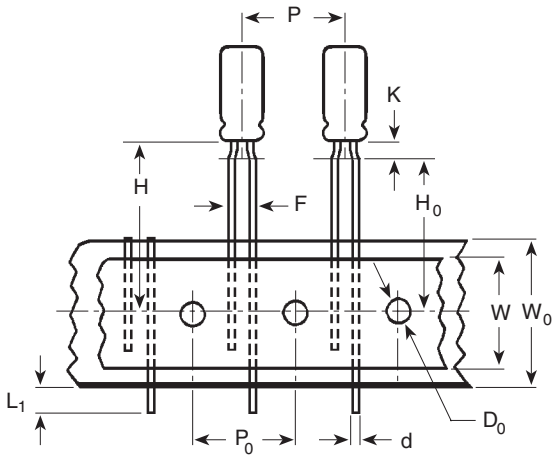


Terminal Code O



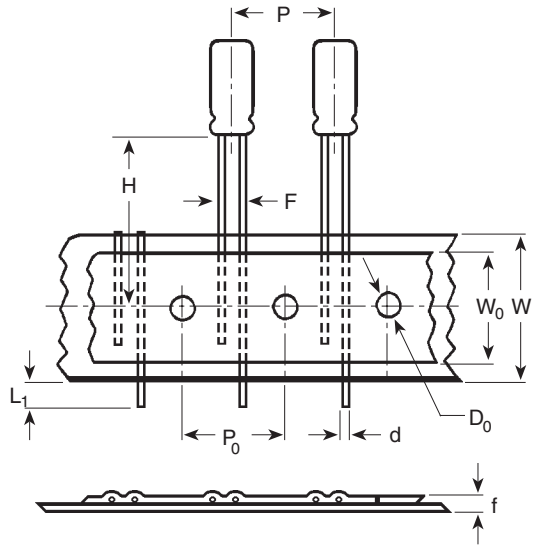
TAPE AND REEL, SPECIFICATIONS TO EIA-468D in inches [millimeters]

Formed Leads



DIMENSIONS in inches [millimeters]		
CASE SIZE	**F LEAD SPACING**	**STD. QTY/REEL**
0.236 x 0.453 [6.0 x 11.0]	0.197 [5.0]	800
0.315 x 0.472 [8.0 x 12.0]	0.197 [5.0]	700

Unformed (Straight) Leads



DIMENSIONS in inches [millimeters]		
CASE SIZE	**F LEAD SPACING**	**STD. QTY/REEL**
0.236 x 0.453 [6.0 x 11.0]	0.098 (1) [2.5]	800
0.315 x 0.472 [8.0 x 12.0]	0.138 (1) [3.5]	700
0.394 x 0.512 [10.0 x 13.0]	0.197 [5.0]	500
0.394 x 0.630 [10.0 x 16.0]	0.197 [5.0]	500
0.394 x 0.787 [10.0 x 20.0]	0.197 [5.0]	500

Note
(1) Available as special order.

DIMENSIONS in inches [millimeters]					
ITEM	**CASE SIZE (Diameter x Length)**				
	0.236 x 0.433 [6.0 x 11.0]	**0.315 x 0.472 [8.0 x 12.0]**	**0.394 x 0.512 [10.0 x 13.0]**	**0.394 x 0.630 [10.0 x 16.0]**	**0.394 x 0.787 [10.0 x 20.0]**
d - Lead-wire diameter	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]
P - Pitch of component	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
P_0 - Feed hole pitch	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
F - Lead-to-lead distance	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]
K - Clinch height	0.098 [2.5]	0.157 [4.0]	N/A	N/A	N/A
H - Height of component from tape center	0.728 [18.5]	0.787 [20.0]	0.906 [23.0]	0.906 [23.0]	0.906 [23.0]
H_0 - Lead-wire clinch height	0.630 [16.0]	0.630 [16.0]	N/A	N/A	N/A
W - Tape width	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0 - Hold down tape width	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]
D_0 - Feed hole diameter	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]
t - Total tape thickness	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]
L_1 -Maximumlead protrusion	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]

Note
Positive leader is standard. Negative leader is available by special order

ORDERING EXAMPLE

Electrolytic capacitor 757D series: 757D 108 M 010 CG 3 D

DESCRIPTION	
CODE	**EXPLANATION**
757D	product type
108	capacitance value (1000 µF)
M	tolerance (M = ± 20 %)
010	voltage rating at 105 °C (6r3 = 6.3 V)
CG	can size (see dimensions table)
3	sleeve and sealing (3 = p.v.c. sleeve w/epoxy end seal)
D	packaging (D = bulk; straight leads)

STANDARD RATINGS in inches [millimeters]							
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR At + 25 °C (mΩ)**		**Max. RIPPLE At + 105 °C(A)**		**Max. Z At + 25 C(mΩ) 100 Hz**
			120 Hz	**20 kHz - 40 kHz**	**120 Hz**	**20 kHz - 40 kHz**	
6.3 WVDC At 105 °C, SURGE = 8 V							
470.0	757D477M6R3BB4D	0.315 x 0.472 [8.0 x 12.0]	523.0	163.0	0.47	0.658	198.0
680.0	757D687M6R3CC4D	0.394 x 0.512 [10.0 x 13.0]	310.0	98.0	0.65	0.907	120.0
820.0	757D827M6R3CD4D	0.394 x 0.630 [10.0 x 16.0]	194.0	77.0	0.88	1.09	96.0
1200.0	757D128M6R3CG4D	0.394 x 0.787 [10.0 x 20.0]	130.0	53.0	1.20	1.47	65.0
2200.0	757D228M6R3DG4D	0.492 x 0.787 [12.5 x 20.0]	113.0	38.0	1.33	1.81	49.0
2700.0	757D278M6R3DK4D	0.492 x 0.984 [12.5 x 25.0]	76.0	31.0	1.78	2.18	40.0
3900.0	757D398M6R3DT4D	0.492 x 1.319 [12.5 x 33.5]	49.0	20.0	2.45	2.98	26.0
5600.0	757D568M6R3DS4D	0.492 x 1.673 [12.5 x 42.5]	34.0	17.0	3.26	3.61	21.0
5600.0	757D568M6R3EK4D	0.630 x 0.984 [16.0 x 25.0]	62.0	22.0	2.15	2.82	28.0
6800.0	757D688M6R3EN4D	0.630 x 1.260 [16.0 x 32.0]	43.0	19.0	2.84	3.35	24.0
8200.0	757D828M6R3ER4D	0.630 x 1.417 [16.0 x 36.0]	35.0	16.0	3.30	3.82	20.0
12 000.0	757D129M6R3EU4D	0.630 x 1.575 [16.0 x 40.0]	31.0	14.0	3.63	4.24	18.0
12 000.0	757D129M6R3FR4D	0.709 x 1.417 [18.0 x 36.0]	38.0	16.5	3.20	3.83	21.0
15 000.0	757D159M6R3FV4D	0.709 x 1.575 [18.0 x 40.0]	32.0	15.0	3.68	4.28	19.0

Note
Case Style 3 = PVC sleeve with resin seal standard. Required for exposure to halogenated cleaning solvents. Case style 4 = PVC sleeve.

STANDARD RATINGS in inches [millimeters]							
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR At + 25 °C (mΩ)**		**Max. RIPPLE At + 105 °C(A)**		**Max. Z At + 25 C(mΩ) 100 Hz**
			120 Hz	**20 kHz - 40 kHz**	**120 Hz**	**20 kHz - 40 kHz**	
10 WVDC At 105 °C, SURGE = 13 V							
330.0	757D337M010BB4D	0.315 x 0.472 [8.0 x 12.0]	576.0	163.0	0.45	0.658	198.0
470.0	757D477M010CC4D	0.394 x 0.512 [10.0 x 13.0]	340.0	98.0	0.62	0.907	120.0
560.0	757D567M010CD4D	0.394 x 0.630 [10.0 x 16.0]	212.0	77.0	0.84	1.09	96.0
1000.0	757D108M010CG4D	0.394 x 0.787 [10.0 x 20.0]	142.0	53.0	1.14	1.47	65.0
1800.0	757D188M010DG4D	0.492 x 0.787 [12.5 x 20.0]	123.0	38.0	1.28	1.81	49.0
2200.0	757D228M010DK4D	0.492 x 0.984 [12.5 x 25.0]	82.0	31.0	1.71	2.18	40.0
10 WVDC At 105 °C, SURGE = 13 V							
2700.0	757D278M010DT4D	0.492 x 1.319 [12.5 x 33.5]	53.0	20.0	2.35	2.98	26.0
3900.0	757D398M010DS4D	0.492 x 1.673 [12.5 x 42.5]	37.0	17.0	3.13	3.61	21.0
3900.0	757D398M010EK4D	0.630 x 0.984 [16.0 x 25.0]	66.0	22.0	2.15	2.82	28.0
5600.0	757D568M010EN4D	0.630 x 1.260 [16.0 x 32.0]	45.0	19.0	2.77	3.35	24.0
6800.0	757D688M010ER4D	0.630 x 1.417 [16.0 x 36.0]	37.0	16.0	3.22	3.82	20.0
8200.0	757D828M010EU4D	0.630 x 1.575 [16.0 x 40.0]	33.0	14.0	3.54	4.24	18.0
8200.0	757D828M010FR4D	0.709 x 1.417 [18.0 x 36.0]	40.0	16.5	3.14	3.83	21.0
10 000.0	757D109M010FV4D	0.709 x 1.575 [18.0 x 40.0]	33.0	15.0	3.61	4.28	19.0
16 WVDC At 105 °C, SURGE = 20 V							
270.0	757D277M016BB4D	0.315 x 0.472 [8.0 x 12.0]	703.0	163.0	0.40	0.658	198.0
330.0	757D337M016CC4D	0.394 x 0.512 [10.0 x 13.0]	410.0	98.0	0.56	0.907	120.0
390.0	757D397M016CD4D	0.394 x 0.630 [10.0 x 16.0]	257.0	77.0	0.77	1.09	96.0
680.0	757D687M016CG4D	0.394 x 0.787 [10.0 x 20.0]	171.0	53.0	1.04	1.47	65.0
1200.0	757D128M016DG4D	0.492 x 0.787 [12.5 x 20.0]	145.0	38.0	1.26	1.81	49.0
1500.0	757D158M016DK4D	0.492 x 0.984 [12.5 x 25.0]	97.0	31.0	1.57	2.18	45.0
2200.0	757D228M016DT4D	0.492 x 1.319 [12.5 x 33.5]	62.0	20.0	2.17	2.98	26.0
3300.0	757D338M016DS4D	0.492 x 1.673 [12.5 x 42.5]	43.0	17.0	2.88	3.61	21.0
2700.0	757D278M016EK4D	0.630 x 0.984 [16.0 x 25.0]	74.0	22.0	2.15	2.82	28.0
3900.0	757D398M016EN4D	0.630 x 1.260 [16.0 x 32.0]	51.0	19.0	2.61	3.35	24.0
4700.0	757D478M016ER4D	0.630 x 1.417 [16.0 x 36.0]	41.0	16.0	3.04	3.82	20.0
5600.0	757D568M016EU4D	0.630 x 1.575 [16.0 x 40.0]	37.0	14.0	3.34	4.24	18.0
6800.0	757D688M016FR4D	0.709 x 1.417 [18.0 x 36.0]	44.0	16.5	3.01	3.83	21.0
8200.0	757D828M016FV4D	0.709 x 1.575 [18.0 x 40.0]	36.0	15.0	3.45	4.28	19.0
25 WVDC At 105 °C, SURGE = 32 V							
180.0	757D187M025BB4D	0.315 x 0.472 [8.0 x 12.0]	851.0	163.0	0.37	0.658	198.0
220.0	757D227M025CC4D	0.394 x 0.512 [10.0 x 13.0]	493.0	98.0	0.51	0.907	120.0
270.0	757D277M025CD4D	0.394 x 0.630 [10.0 x 16.0]	308.0	77.0	0.70	1.09	96.0
470.0	757D477M025CG4D	0.394 x 0.787 [10.0 x 20.0]	206.0	53.0	0.95	1.47	65.0
820.0	757D827M025DG4D	0.492 x 0.787 [12.5 x 20.0]	171.0	38.0	1.12	1.81	49.0
1000.0	757D108M025DK4D	0.492 x 0.984 [12.5 x 25.0]	114.0	31.0	1.45	2.18	40.0
1500.0	757D158M025DT4D	0.492 x 1.319 [12.5 x 33.5]	73.0	20.0	1.99	2.98	26.0
2200.0	757D228M025DS4D	0.492 x 1.673 [12.5 x 42.5]	51.0	17.0	2.66	3.61	21.0
1800.0	757D188M025EK4D	0.630 x 0.984 [16.0 x 25.0]	83.0	22.0	2.15	2.82	28.0
2700.0	757D278M025EN4D	0.630 x 1.260 [16.0 x 32.0]	57.0	19.0	2.46	3.35	24.0
3300.0	757D338M025ER4D	0.630 x 1.417 [16.0 x 36.0]	47.0	16.0	2.87	3.82	20.0
3900.0	757D398M025EU4D	0.630 x 1.575 [16.0 x 40.0]	41.0	14.0	3.15	4.24	18.0
3900.0	757D398M025FR4D	0.709 x 1.417 [18.0 x 36.0]	48.0	16.5	2.87	3.83	21.0
4700.0	757D478M025FV4D	0.709 x 1.575 [18.0 x 40.0]	40.0	15.0	3.30	4.28	19.0

Note

Case Style 3 = PVC sleeve with resin seal standard. Required for exposure to halogenated cleaning solvents. Case style 4 = PVC sleeve.

Aluminum Capacitors
+ 105 °C, Miniature, Radial Lead

STANDARD RATINGS in inches [millimeters]							
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR At + 25 °C (mΩ)**		**Max. RIPPLE At + 105 °C(A)**		**Max. Z At + 25 C(mΩ) 100 Hz**
			120 Hz	**20 kHz - 40 kHz**	**120 Hz**	**20 kHz - 40 kHz**	
35 WVDC At 105 °C, SURGE = 44 V							
120.0	757D127M035BB4D	0.315 x0 .472 [8.0 x 12.0]	1073.0	163.0	0.33	0.658	198.0
150.0	757D157M035CC4D	0.394 x 0.512 [10.0 x 13.0]	617.0	98.0	0.46	0.907	120.0
180.0	757D187M035CD4D	0.394 x 0.630 [10.0 x 16.0]	386.0	77.0	0.62	1.09	96.0
330.0	757D337M035CG4D	0.394 x 0.787 [10.0 x 20.0]	257.0	53.0	0.85	1.47	65.0
560.0	757D567M035DG4D	0.492 x 0.787 [12.5 x 20.0]	210.0	38.0	1.12	1.81	49.0
680.0	757D687M035DK4D	0.492 x 0.984 [12.5 x 25.0]	140.0	31.0	1.35	2.18	40.0
1000.0	757D108M035DT4D	0.492 x 1.319 [12.5 x 33.5]	90.0	20.0	1.80	2.98	26.0
1500.0	757D158M035DS4D	0.492 x 1.673 [12.5 x 42.5]	63.0	17.0	2.40	3.61	21.0
1200.0	757D128M035EK4D	0.630 x 0.984 [16.0 x 25.0]	97.0	22.0	2.15	2.82	28.0
1800.0	757D188M035EN4D	0.630 x 1.260 [16.0 x 32.0]	67.0	19.0	2.28	3.35	24.0
2200.0	757D228M035ER4D	0.630 x 1.417 [16.0 x 36.0]	54.0	16.0	2.65	3.82	20.0
2700.0	757D278M035EU4D	0.630 x 1.575 [16.0 x 40.0]	48.0	14.0	2.92	4.24	18.0
2700.0	757D278M035FR4D	0.709 x 1.417 [18.0 x 36.0]	54.0	16.5	2.69	3.83	21.0
3300.0	757D338M035FV4D	0.709 x 1.575 [18.0 x 40.0]	45.0	15.0	3.09	4.28	19.0

Note
Case Style 3 = PVC sleeve with resin seal standard. Required for exposure to halogenated cleaning solvents. Case style 4 = PVC sleeve.

Aluminum Capapcitors
+ 105 °C, Miniature, Radial Lead

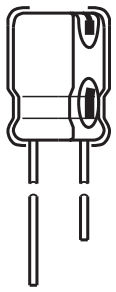


Fig.1 Component outline

FEATURES

- Original SMPS output capacitors
- Minimal ESR change
- High ripple current capability

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.394" x 0.472" [10.0 x 12.0] to 0.709" x 1.575" [18.0 x 40.0]
Operating temperature	- 55 °C to + 105 °C
Rated capacitance range, C_R	4.7 µF to 3300 µF
Tolerance on C_R	- 10 %, + 50 %
Rated voltage range, U_R	6.3 WVDC to 250 WVDC
Termination	2 and 3 radial leads and axial mount.
Life validation test at 105 °C	4000 hours (> 0.394" [10.0] diameter): 3000 hours (> 0.394" [10.0] diameter): Δ CAP ≤ 20 % from individual measurement. Δ ESR ≤ 1.15 x initial specified limit. Δ DCL ≤ 3 x initial specified limit.
Shelf life at 105 °C	500 hours: Δ CAP ≤ 10 % from initial measurement. Δ ESR ≤ 1.15 x initial specified limit. Δ DCL ≤ 2 x initial specified limit, (6.3 WVDC to 100 WVDC); ≤ 3 x initial specified limit, (150 WVDC to 250 WVDC).
DC leakage current at 25 °C	6.3 WVDC to 100 WVDC $I = 0.03 \sqrt{CV}$ 150 WVDC to 250 WVDC I = 0.01 CV I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE				
Ambient Temperature	**Multipliers**			
+ 105 °C	0.5			
+ 85 °C	1.0			
≤ + 75 °C	1.25			
FREQUENCY (Hz)				
WVDC	**50 - 60**	**100 - 120**	**300 - 400**	**1K to 19K**
0 - 75	0.60	0.70	0.75	0.80
76 - 100	0.40	0.55	0.70	0.80
101 - 250	0.25	0.35	0.45	0.65

LOW TEMPERATURE PERFORMANCE

CAPACITANCE RATIO $C_{-55\,°C}/C_{+25\,°C}$ MINIMUM AT 120 Hz				
Maximum Capacitance Change	**Voltage**	**Multiplier**		
	6.3 V - 100 V	0.75		
	150 v - 250 V	0.70		
Maximum Impedance Change	**Voltage**	**Multiplier**		
	6.3 V - 100 V	2.5		
	150 v - 250 V	2.0		
ESL (TYPICAL VALUES AT 1 MHz TO 10 MHz)				
Nominal diameter	0.394	0.512	0.630	0.709
Typical ESL (nH)	4.0	7.0	10.0	12.0

DIMENSIONS in inches [millimeters]

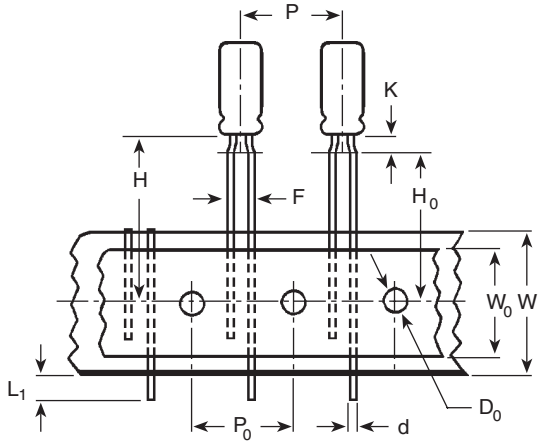
CASE CODE	NOMINAL		STYLES 2 AND 4		STYLES 3 AND 5		LEAD SPACING		LEAD DIAMETER	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.024 [0.60]	T ± 0.020 [0.50]	Nominal	AWG
CC	0.394 [10.0]	0.512 [13.0]	0.413 [10.5]	0.563 [14.3]	0.413 [10.5]	0.630 [16.0]	0.197 [5.0]	N/A	0.025 [0.63]	22
CD	0.394 [10.0]	0.630 [16.0]	0.413 [10.5]	0.669 [17.0]	0.413 [10.5]	0.740 [18.8]	0.197 [5.0]	N/A	0.025 [0.63]	22
CG	0.394 [10.0]	0.787 [20.0]	0.413 [10.5]	0.846 [21.5]	0.413 [10.5]	0.906 [23.0]	0.197 [5.0]	N/A	0.025 [0.63]	22
DG	0.492 [12.5]	0.787 [20.0]	0.512 [13.0]	0.846 [21.5]	0.512 [13.0]	0.906 [23.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
DK	0.492 [12.5]	0.984 [25.0]	0.512 [13.0]	1.043 [26.5]	0.512 [13.0]	1.142 [29.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
DM	0.492 [12.5]	1.043 [26.5]	0.512 [13.0]	1.102 [28.0]	0.512 [13.0]	1.161 [29.5]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
DT	0.492 [12.5]	1.319 [33.5]	0.512 [13.0]	1.346 [34.2]	0.512 [13.0]	1.417 [36.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
DS	0.492 [12.5]	1.673 [42.5]	0.512 [13.0]	1.720 [43.7]	0.512 [13.0]	1.791 [45.5]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
EK	0.630 [16.0]	0.984 [25.0]	0.650 [16.5]	1.031 [26.2]	0.650 [16.5]	1.098 [27.9]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
EN	0.630 [16.0]	1.260 [32.0]	0.650 [16.5]	1.319 [33.5]	0.650 [16.5]	1.417 [36.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
ER	0.630 [16.0]	1.417 [36.0]	0.650 [16.5]	1.476 [37.5]	0.650 [16.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20

For technical questions, contact: aluminumcaps4@vishay.com
Document Number: 42054
Revision: 16-Jul-08

DIMENSIONS in inches [millimeters]										
CASE CODE	NOMINAL		STYLES 2 AND 4		STYLES 3 AND 5		LEAD SPACING		LEAD DIAMETER	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.024 [0.60]	T ± 0.020 [0.50]	Nominal	AWG
EU	0.630 [16.0]	1.575 [40.0]	0.650 [16.5]	1.642 [41.7]	0.650 [16.5]	1.669 [42.4]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
FR	0.709 [18.0]	1.417 [36.0]	0.728 [18.5]	1.476 [37.5]	0.728 [18.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
FV	0.709 [18.0]	1.575 [40.0]	0.728 [18.5]	1.653 [42.0]	0.728 [18.5]	1.693 [43.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20

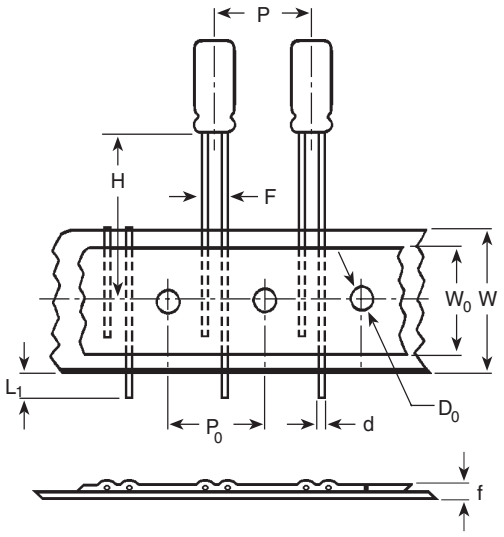
TAPE AND REEL, SPECIFICATIONS TO EIA-468D in inches [millimeters]

Formed Leads



DIMENSIONS in inches [millimeters] **AND PACKAGING QUANTITIES**		
CASE SIZE	F LEAD SPACING	STD. QTY/REEL
0.236 x 0.453 [6.0 x 11.0]	0.197 [5.0]	800
0.315 x 0.472 [8.0 x 12.0]	0.197 [5.0]	700

Unformed (Straight) Leads



DIMENSIONS in inches [millimeters] **AND PACKAGING QUANTITIES**		
CASE SIZE	F LEAD SPACING	STD. QTY/REEL
0.236 x 0.453 [6.0 x 11.0]	0.098 [2.5]	800
0.315 x 0.472 [8.0 x 12.0]	0.140 [3.5] (1)	700
0.394 x 0.512 [10.0 x 13.0]	0.197 [5.0]	500
0.394 x 0.630 [10.0 x 16.0]	0.197 [5.0]	500
0.394 x 0.787 [10.0 x 20.0]	0.197 [5.0]	500

Note (1) Available as special order.

DIMENSIONS in inches [millimeters]					
ITEM	**CASE SIZE (Diameter x Length)**				
	0.236 x 0.433 [6.0 x 11.0]	**0.315 x 0.472 [8.0 x 12.0]**	**0.394 x 0.512 [10.0 x 13.0]**	**0.394 x 0.630 [10.0 x 16.0]**	**0.394 x 0.787 [10.0 x 20.0]**
d - Lead-wire diameter	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]
P - Pitch of component	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
P_0 - Feed hole pitch	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
F - Lead-to-lead distance	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]
K - Clinch height	0.098 [2.5]	0.157 [4.0]	N/A	N/A	N/A
H - Height of component from tape center	0.728 [18.5]	0.787 [20.0]	0.906 [23.0]	0.906 [23.0]	0.906 [23.0]
H_0 - Lead-wire clinch height	0.630 [16.0]	0.630 [16.0]	N/A	N/A	N/A
W - Tape width	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0 - Hold down tape width	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]
D_0 - Feed hole diameter	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]
f - Total tape thickness	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]
L_1 -Maximum lead protrusion	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]

Note
Positive leader is standard. Negative leader is available by special order.

ORDERING EXAMPLE

Electrolytic capacitor 672D series: 672D 336 F 100 DM 5 D

DESCRIPTION	
CODE	**EXPLANATION**
672D	product type
336	capacitance value (33 µF)
F	tolerance (F = - 10 %/+ 50 %)
100	voltage rating at 105 °C (100 = 100 V)
DM	can size (see dimensions table)
5	sleeve and sealing (5 = polyester sleeve w/epoxy end seal)
D	packaging (D = bulk; straight leads)

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR AT + 25 °C (mΩ)**		**Max. RIPPLE AT + 85 °C (A)**	**Max. IMPEDANCE AT + 25 °C (mΩ) 100 Hz**
			120 Hz	**20 kHz**	**20 kHz - 100 kHz**	
6.3 WVDC AT 105 °C, SURGE = 9 V						
150.0	672D157F6RCD5D	0.394 x 0.630 [10.0 x 16.0]	1.10	0.70	0.50	0.60
220.0	672D227F6RCG5D	0.394 x 0.787 [10.0 x 20.0]	0.75	0.40	0.70	0.33
1000.0	672D108F6REK5D	0.630 x 0.984 [16.0 x 25.0]	0.16	0.09	2.05	0.085
1500.0	672D158F6RET5D	0.630 x 1.319 [16.0 x 33.5]	0.105	0.06	2.90	0.055
3300.0	672D338F6RFV5D	0.709 x 1.575 [18.0 x 40.0]	0.075	0.045	3.40	0.045
12 WVDC AT 105 °C, SURGE = 16 V						
100.0	672D107F012CC5D	0.394 x 0.512 [10.0 x 13.0]	1.60	0.90	0.40	0.70
470.0	672D477F012CM5D	0.492 x 1.043 [12.5 x 26.5]	0.31	0.16	1.35	0.12
1000.0	672D108F012DS5D	0.492 x 1.673 [12.5 x 42.5]	0.15	0.08	2.35	0.06
2200.0	672D228F012FV5D	0.709 x 1.575[18.0 x 40.0]	0.08	0.05	3.30	0.05
15 WVDC AT 105 °C, SURGE = 20 V						
100.0	672D107F015CD5D	0.394 x 0.630 [10.0 x 16.0]	1.35	0.70	0.50	0.50
470.0	672D477F015DT5D	0.492 x 1.319 [12.5 x 35.5]	0.25	0.12	1.75	0.11
1000.0	672D108F015ET5D	0.630 x 1.319 [16.0 x 33.5]	0.12	0.06	2.90	0.055
20 WVDC AT 105 °C, SURGE = 30 V						
100.0	672D107F020CG5D	0.394 x 0.787 [10.0 x 20.0]	1.25	0.40	0.70	0.35
470.0	672D477F020EK5D	0.630 x 0.984 [16.0 x 25.0]	0.24	0.09	2.00	0.085
1000.0	672D158F020FV5D	0.709 x 1.575 [18.0 x 40.0]	0.09	0.05	3.25	0.05

Aluminum Capapcitors
+ 105 °C, Miniature, Radial Lead

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR AT + 25 °C (mΩ)**		**Max. RIPPLE AT + 85 °C (A)**	**Max. IMPEDANCE AT + 25 °C (mΩ) 100 Hz**
			120 Hz	**20 kHz**	**20 kHz - 100 kHz**	
25 WVDC AT 105 °C, SURGE = 35 V						
47.0	672D476F025CC5D	0.394 x 0.512 [10.0 x 13.0]	2.35	0.90	0.40	0.85
330.0	672D337F025DT5D	0.492 x 1.319 [12.5 x 33.5]	0.29	0.12	1.75	0.10
470.0	672D477F025DS5D	0.492 x 1.673 [12.5 x 42.5]	0.22	0.08	2.35	0.07
1200.0	672D128F025FV5D	0.709 x 1.575 [18.0 x 40.0]	0.10	0.05	3.20	0.055
40 WVDC AT 105 °C, SURGE = 55 V						
220.0	672D227F040EK5D	0.630 x 0.984 [16.0 x 25.0]	0.48	0.14	1.65	0.12
330.0	672D337F040ET5D	0.630 x 1.319 [16.0 x 33.5]	0.32	0.12	2.25	0.08
50 WVDC AT 105 °C, SURGE = 75 V						
100.0	672D107F050DT5D	0.492 x 1.319 [12.5 x 33.5]	0.80	0.26	1.15	0.22
150.0	672D157F050EK5D	0.630 x 0.984[16.0 x 25.0]	0.55	0.22	1.30	0.18
220.0	672D277F050ET5D	0.630 x 1.319 [16.0 x 33.5]	0.40	0.15	1.85	0.12
470.0	672D477F050FV5D	0.709 x 1.575 [18.0 x 40.0]	0.25	0.09	2.40	0.095
60 WVDC AT 105 °C, SURGE = 85 V						
15.0	672D156F060CD5D	0.394 x 0.512 [10.0 x 13.0]	7.00	2.00	0.28	1.70
22.0	672D226F060CG5D	0.394 x 0.787 [10.0 x 20.0]	4.60	1.20	0.40	1.00
100.0	672D107F060EK5D	0.630 x 0.984 [16.0 x 25.0]	0.90	0.28	1.20	0.24
150.0	672D157F060ET5D	0.630 x 1.319 [16.0 x 33.5]	0.60	0.18	1.65	0.15
75 WVDC AT 105 °C, SURGE = 100 V						
12.0	672D126F075CD5D	0.394 x 0.512 [10.0 x 13.0]	8.50	2.20	0.26	1.75
120.0	672D127F075ET5D	0.630 x 1.319 [16.0 x 33.5]	0.68	0.18	1.50	0.16
100 WVDC AT 105 °C, SURGE = 125 V						
10.0	672D106F100CD5D	0.394 x 0.630 [10.0 x 16.0]	10.00	2.30	0.26	1.80
33.0	672D336F100DM5D	0.492 x 1.043 [12.5 x 26.5]	2.55	0.55	0.72	0.39
120.0	672D127F100ET5D	0.630 x 1.319 [16.0 x 33.5]	0.68	0.19	1.50	0.17
200 WVDC AT 105 °C, SURGE = 250 V						
4.7	672D475F200CG5D	0.394 x 0.787 [10.0 x 20.0]	22.50	1.95	0.31	1.75
15.0	672D156F200DT5D	0.492 x 1.319 [12.5 x 33.5]	7.00	0.58	0.76	0.55
47.0	672D476F200FV5D	0.709 x 1.575 [18.0 x 40.0]	2.30	0.18	1.90	0.165
250 WVDC AT 105 °C, SURGE = 300 V						
10.0	672D106F250DT5D	0.492 x 1.319 [12.5 x 33.5]	12.00	1.50	0.48	1.60

ORIGINAL RATINGS		
CAPACITANCE (µF)	**CASE CODE**	**PART NUMBER**
6.3 WVDC AT 105 °C, SURGE = 9 V		
150.0	CD	672D157H6R3CD5C
220.0	CG	672D227H6R3CG5C
680.0	DM	672D687H6R3DM5C
1000.0	EK	672D108H6R3EK5C
1200.0	DS	672D158H6R3ET5C
3300.0	FV	672D338H6R3FV5C
7.5 WVDC AT 105 °C, SURGE = 10 V		
100.0	CC	672D107H7R5CC5C
150.0	CD	672D157H7R5CD5C
680.0	DT	672D687H7R5DT5C
1000.0	ET	672D108H7R5ET5C
2700.0	FV	672D278H7R5FV5C

Notes

(1) Capacitance Tolerance Code H, - 10 %, + 100 %; Lead Code C, cut leads. C Lead = Negative Lead: 0.281" [7.1 mm], ± 0.062" [1.6 mm]; Positive Lead: 0375" [9.5 mm], ± 0.062" [1.6 mm]. D Lead = 1.0" [25.4 mm] minimum.

ORIGINAL RATINGS		
CAPACITANCE (µF)	CASE CODE	PART NUMBER
12 WVDC AT 105 °C, SURGE = 16 V		
100.0	CC	672D107H012CC5C
150.0	CG	672D157H012CG5C
470.0	DM	672D477H012DM5C
680.0	DT	672D687H012DT5C
1000.0	DS	672D108H012DS5C
2200.0	FV	672D228H012FV5C
15 WVDC AT 105 °C, SURGE = 20 V		
100.0	CD	672D107H015CD5C
150.0	CG	672D157H015CG5C
470.0	DT	672D477H015DT5C
680.0	EK	672D687H015EK5C
820.0	DS	672D827H015DS5C
1000.0 (1)	ET	672D108H015ET5C
1800.0	FV	672D188H015FV5C
20 WVDC AT 105 °C, SURGE = 30 V		
68.0	CD	672D868H020CD5C
100.0	CG	672D107H020CG5C
330.0	DM	672D337H020DM5C
470.0	EK	672D477H020EK5C
560.0	DS	672D567H020DS5C
680.0	ET	672D687H020ET5C
1500.0	FV	672D158H020FV5C
25 WVDC AT 105 °C, SURGE = 35 V		
47.0	CC	672D476H025CC5C
68.0	CD	672D686H025CD5C
330.0	DT	672D337H025DT5C
470.0	DS	672D477H025DS5C
680.0	EU	672D687H025EU5C
1200.0	FV	672D128H025FV5C
40 WVDC AT 105 °C, SURGE = 55 V		
47.0	CD	672D476H040CD5C
220.0	EK	672D227H040EK5C
330.0	ET	672D337H040ET5C
390.0	DS	672D397H040DS5C
820.0	FV	672D827H040FV5C
50 WVDC AT 105 °C, SURGE = 75 V		
22.0	CD	672D226H050CD5C
100.0	DT	672D107H050DT5C
150.0	EK	672D157H050EK5C
180.0	DS	672D187H050DS5C
220.0	ET	672D227H050ET5C
470.0	FV	672D477H050FV5C
60 WVDC AT 105 °C, SURGE = 85 V		
15.0	CD	672D156H060CD5C
22.0	CG	672D226H060CG5C
68.0 (1)	DM	672D686H060DM5C
100.0	EK	672D107H060EK5C
120.0	DS	672D127H060DS5C
150.0	ET	672D157H060ET5C
390.0	FV	672D397H060FV5C

Notes

(1) Capacitance Tolerance Code H, - 10 %, + 100 %; Lead Code C, cut leads. C Lead = NegATive Lead: 0.281" [7.1 mm], ± 0.062" [1.6 mm]; Positive Lead: 0375" [9.5 mm], ± 0.062" [1.6 mm]. D Lead = 1.0" [25.4 mm] minimum.

Aluminum Capapcitors
+ 105 °C, Miniature, Radial Lead

ORIGINAL RATINGS		
CAPACITANCE (µF)	**CASE CODE**	**PART NUMBER**
75 WVDC AT 105 °C, SURGE = 100 V		
12.0	CD	672D126H075CD5C
18.0	CG	672D186H075CG5C
82.0	EK	672D826H075EK5C
120.0	ET	672D127H075ET5C
270.0	FV	672D277H075FV5C
100 WVDC AT 105 °C, SURGE = 125 V		
8.2	CC	672D825H100CC5C
10.0	CD	672D106H100CD5C
33.0	DM	672D336H100DM5C
68.0	EK	672D686H100EK5C
120.0	ET	672D127H100ET5C
180.0	FV	672D187H100FV5C
150 WVDC AT 105 °C, SURGE = 200 V		
6.8	CG	672D685H150CG5C
22.0	DT	672D226H150DT5C
39.0	ET	672D396H150ET5C
68.0	FV	672D686H150FV5C
200 WVDC AT 105 °C, SURGE = 250 V		
4.7	CG	672D475H200CG5C
15.0	DT	672D156H200DT5C
27.0	ET	672D276H200ET5C
47.0	FV	672D476H200FV5C
250 WVDC AT 105 °C, SURGE = 300 V		
8.2	DM	672D825H250DM5C
10.0	DT	672D106H250DT5C
22.0	ET	672D226H250ET5C
39.0	FV	672D396H250FV5C

Notes

(1) Capacitance Tolerance Code H, - 10 %, + 100 %; Lead Code C, cut leads. C Lead = Negative Lead: 0.281" [7.1 mm], ± 0.062" [1.6 mm]; Positive Lead: 0375" [9.5 mm], ± 0.062" [1.6 mm]. D Lead = 1.0" [25.4 mm] minimum.

Aluminum Capacitors
+ 105 °C, Miniature, Radial Lead

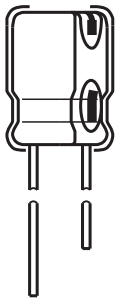


Fig.1 Component outline

FEATURES

- Broad operating range
- Low DC leakage current and dissipation factor
- Suitable for solid tantalum replacement applications

Pb-free Available

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	0.236" x 0.433" [6.0 x 11.0] to 0.394" x 0.787" [10.0 x 20.0] (nominal)
Operating temperature	- 40 °C to + 105 °C
Rated capacitance range, C_R	1.0 µF to 330 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 63 WVDC
Termination	Radial leads
Life validation test at 105 °C	2000 hours: Δ CAP ≤ 15 % (6.3 WVDC to 10 WVDC), ≤ 10 % (16 WVDC to 63 WVDC) from initial measurement. Δ DF ≤ 1.25 x initial specified limit. Δ DCL ≤ initial specified limit.

DIMENSIONS in inches [millimeters]

CASE CODE	D (max.)	H (max.)	S	W1	W2	LEAD AWG NO.
AA	0.256 [6.502]	0.597 [15.164]	0.100 [2.540]	0.787 [19.990]	0.948 [24.079]	22
BB	0.335 [8.509]	0.638 [16.205]	0.138 [3.505]	0.787 [19.990]	0.948 [24.079]	22
CC	0.414 [10.516]	0.650 [16.510]	0.200 [5.080]	0.787 [19.990]	0.948 [24.079]	22
CD	0.414 [10.516]	0.784 [19.914]	0.200 [5.080]	0.562 [14.275]	0.688 [17.475]	22
CG	0.414 [10.516]	0.945 [24.003]]	0.200 [5.080]	0.562 [14.275]	0.688 [17.475]	22

ORDERING EXAMPLE

Electrolytic capacitor 510D series: 510D 226 M 016 AA 3 D

DESCRIPTION	
CODE	**EXPLANATION**
510D	product type
226	capacitance value (22 µF)
M	tolerance (M = ± 20 %)
016	voltage rating at 105 °C (016 = 16 V)
AA	can size (see dimensions table)
3	sleeve and sealing (3 = p.v.c. sleeve w/epoxy end seal)
D	packaging (D = bulk; straight leads)

For technical questions, contact: aluminumcaps4@vishay.com

Document Number: 42049
Revision: 30-Jul-08

STANDARD RATINGS in inches [millimeters]		
CAPACITANCE (µF)	**CASE CODE**	**PART NUMBER**
6.3 WVDC AT + 105 °C, SURGE = 9 V		
47.0	AA	510D476M6R3AA3D
100.0	BB	510D107M6R3BB3D
150.0	CC	510D157M6R3CC3D
220.0	CD	510D227M6R3CD3D
330.0	CG	510D337M6R3CG3D
10 WVDC AT + 105 °C, SURGE = 15 V		
33.0	AA	510D336M010AA3D
68.0	BB	510D686M010BB3D
100.0	CC	510D107M010CC3D
150.0	CD	510D157M010CD3D
220.0	CG	510D227M010CG3D
16 WVDC AT + 105 °C, SURGE = 20 V		
22.0	AA	510D226M016AA3D
47.0	BB	510D476M016BB3D
68.0	CC	510D686M016CC3D
100.0	CD	510D107M016CD3D
150.0	CG	510D157M016CG3D
25 WVDC AT + 105 °C, SURGE = 35 V		
15.0	AA	510D156M025AA3D
33.0	BB	510D336M025BB3D
68.0	CD	510D686M025CD3D
100.0	CG	510D107M025CG3D
35 WVDC AT + 105 °C, SURGE = 45 V		
10.0	AA	510D106M035AA3D
22.0	BB	510D226M035BB3D
33.0	CC	510D336M035CC3D
47.0	CG	510D476M035CG3D
50 WVDC AT + 105 °C, SURGE = 65 V		
1.0	see 63 V Listing	-
1.5	see 63 V Listing	-
2.2	see 63 V Listing	-
3.3	see 63 V Listing	-
4.7	see 63 V Listing	-
6.8	AA	510D685M050AA3D
10.0	see 63 V Listing	-
15.0	BB	510D156M050BB3D
22.0	CC	510D226M050CC3D
63 WVDC AT + 105 °C, SURGE = 80 V		
1.0	AA	510D105M063AA3D
1.5	AA	510D155M063AA3D
2.2	AA	510D225M063AA3D
3.3	AA	510D335M063AA3D
4.7	AA	510D475M063AA3D
6.8	BB	510D685M063BB3D
10.0	BB	510D106M063BB3D
15.0	CC	510D156M063CC3D

Aluminum Capacitors
+ 105 °C, Tubular Radial Lead

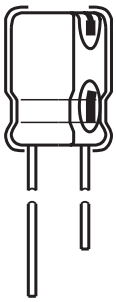


Fig.1 Component outline

FEATURES

- Wide temperature range
- Radial design in two and three lead configuration
- Ideal SMPS output filter

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.75" x 1.125" [1.905 x 28.575] to 1.0" x 3.625" [25.4 x 92.075]
Operating temperature	- 55 °C to + 105 °C
Rated capacitance range, C_R	22 µF to 27 000 µF
Tolerance on C_R	- 10 %, + 50 %
Rated voltage range, U_R	6.3 WVDC to 250 WVDC
Termination	radial leads
Life validation test at + 105 °C	2000 h: ΔCAP ≤ 15 % from initial measurement ΔESR ≤ 1.5 x initial specified limit ΔDCL ≤ initial specified limit
Shelf life at + 105 °C	500 h: ΔCAP ≤ 10 % from initial measurement ΔESR ≤ 1.15 x initial specified limit ΔDCL ≤ 2 x initial specified limit
DC leakage current at + 25 °C	$I = K \sqrt{CV}$ K = 0.5 I in µA, C in µF, V in volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE	
Ambient Temperature	**Multipliers**
+ 105 °C	0.4
+ 85 °C	1.0
+ 65 °C	1.4
+ 45 °C	1.7
+ 25 °C	2.0

FREQUENCY (Hz)					
Rated WVDC	**50 to 60**	**100 to 120**	**300 to 400**	**1000**	**20 000**
0 to 60	0.60	0.75	0.80	0.90	1.0
61 to 250	0.43	0.54	0.75	0:85	1.0

LOW TEMPERATURE PERFORMANCE

CAPACITANCE RATIO $C_{-55\,°C}/C_{+25\,°C}$ MINIMUM AT 120 Hz			
Rated Voltage (WVDC)	6.3 to 25	40 to 100	150 to 250
Capacitance Remaining	75 %	80 %	65 %
ESR RATIO $ESR_{-55\,°C}/ESR_{+25\,°C}$ MAXIMUM AT 120 Hz			
Rated Voltage (WVDC)	0 to 12	13 to 40	41 to 250
Multipliers	8	10	16
ESL (TYPICAL VALUES AT 1 MHz TO 10 MHz)			
Nominal Diameter	0.75 [19.0.]	0.875 [22.0]	1.00 [25.0]
Typical ESL (nH)	10	11	13

DIMENSIONS in inches [millimeters]

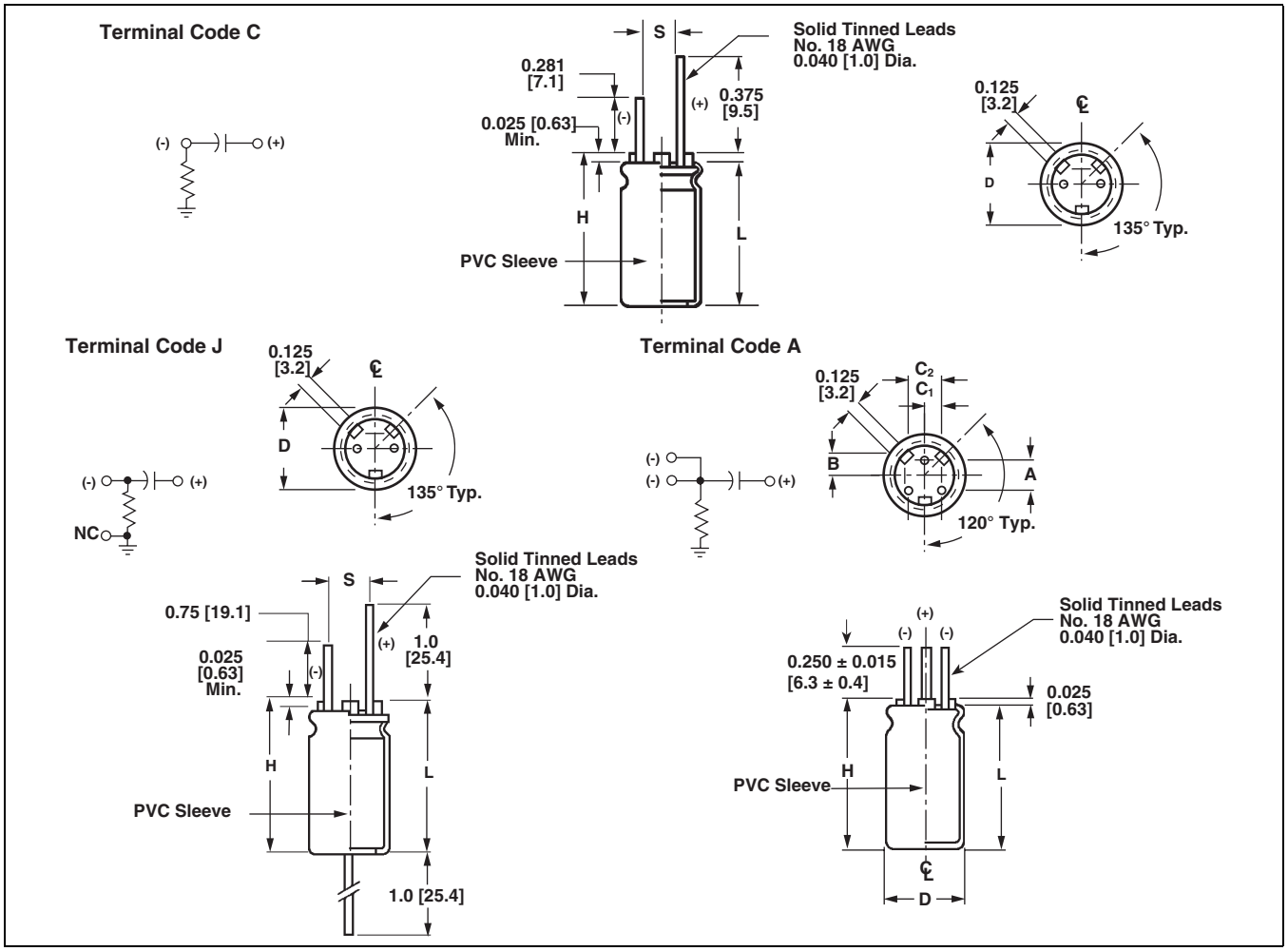
CASE CODE	STYLE 1 STYLE 7		OVERALL LENGTH	LEAD SPACING (1)	TYPICAL WEIGHT
	D ± 0.015 [0.4]	L ± 0.062 [1.6]	H (MAX.)	S ± 0.015 [0.4]	oz. (g)
GE	0.770 [19.6]	1.150 [29.2]	1.246 [31.6]	0.250 [6.4]	0.46 (13)
GJ	0.770 [19.6]	1.650 [41.9]	1.746 [44.3]	0.250 [6.4]	0.67 (19)
GL	0.770 [19.6]	2.150 [54.6]	2.246 [57.0]	0.250 [6.4]	0.74 (21)
GP	0.770 [19.6]	2.650 [67.3]	2.746 [69.7]	0.250 [6.4]	0.88 (25)
GS	0.770 [19.6]	3.150 [80.0]	3.246 [82.4]	0.250 [6.4]	1.16 (33)
GT	0.770 [19.6]	3.650 [92.7]	3.746 [95.1]	0.250 [6.4]	1.34 (38)
HE	0.895 [22.7]	1.150 [29.2]	1.246 [31.6]	0.300 [7.6]	0.63 (18)
HJ	0.895 [22.7]	1.650 [41.9]	1.746 [44.3]	0.300 [7.6]	0.95 (27)
HL	0.895 [22.7]	2.150 [54.6]	2.246 [57.0]	0.300 [7.6]	1.02 (29)
HP	0.895 [22.7]	2.650 [67.3]	2.746 [69.7]	0.300 [7.6]	1.37 (39)

DIMENSIONS in inches [millimeters]					
CASE CODE	**STYLE 1 STYLE 7**		**OVERALL LENGTH**	**LEAD SPACING (1) S ± 0.015 [0.4]**	**TYPICAL WEIGHT oz. (g)**
	D ± 0.015 [0.4]	**L ± 0.062 [1.6]**	**H (MAX.)**		
HS	0.895 [22.7]	3.150 [80.0]	3.246 [82.4]	0.300 [7.6]	1.73 (49)
HT	0.895 [22.7]	3.650 [92.7]	3.746 [95.1]	0.300 [7.6]	2.08 (59)
JE	1.020 [25.9]	1.150 [29.2]	1.246 [31.6]	0.400 [10.2]	0.81 (23)
JJ	1.020 [25.9]	1.650 [41.9]	1.746 [44.3]	0.400 [10.2]	1.02 (29)
JL	1.020 [25.9]	2.150 [54.6]	2.246 [57.0]	0.400 [10.2]	1.20 (34)
JP	1.020 [25.9]	2.650 [67.3]	2.746 [69.7]	0.400 [10.2]	1.87 (53)
JS	1.020 [25.9]	3.150 [80.0]	3.246 [82.4]	0.400 [10.2]	2.22 (63)
JT	1.020 [25.9]	3.650 [92.7]	3.746 [95.1]	0.400 [10.2]	2.54 (72)
LEAD SPACING					
CASE DIAMETER		**A ± 0.015 [0.4]**	**B ± 0.015 [0.4]**	**C_1 ± 0.015 [0.4]**	**C_2 ± 0.015 [0.4]**
0.750 [19.1]		0.300 [7.6]	0.167 [4.23]	0.100 [2.5]	0.200 [5.1]
0.875 [22.2]		0.400 [10.2]	0.228 [5.79]	0.150 [3.8]	0.300 [7.6]
1.000 [25.4]		0.400 [10.2]	0.228 [5.79]	0.150 [3.8]	0.300 [7.6]

Note

(1) Type U673D only

DIMENSIONS in inches [millimeters] **AND AVAILABLE FORMS**



ORDERING EXAMPLE

Electrolytic capacitor U673D and U674D series: U673D 228 F 6R3 GE 1 C

DESCRIPTION	
CODE	**EXPLANATION**
U673D	product type
228	capacitance value (2200 µF)
F	capacitance tolerance (F = - 10 %, + 50 %; H = - 10 %, + 100 %)
6R3	voltage rating at 105 °C (6R3 = 6.3 V)
GE	can size (see dimensions table)
1	sleeve and sealing (1 = p.v.c. sleeve)
C	terminal code (see available forms tables)

STANDARD RATINGS in inches [millimeters]

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	MAX. ESR AT + 25 °C (mΩ)		MAX. RIPPLE AT + 85 °C (A)	MAX. Z AT 100 kHz (mΩ)
			120 Hz	20 kHz to 40 kHz	20 kHz to 40 kHz	
6.3 WVDC AT 105 °C, SURGE = 9 V						
2200.0	U673D228F6R3GE1C	0.770 x 1.150 [19.6 x 29.2]	105.0	81.0	2.30	83.0
4700.0	U673D478F6R3GJ1C	0.770 x 1.650 [19.6 x 41.9]	53.0	41.0	3.70	43.0
6800.0	U673D688F6R3GL1C	0.770 x 2.150 [19.6 x 54.6]	36.0	28.0	4.95	30.0
8200.0	U673D828F6R3GP1C	0.770 x 2.650 [19.6 x 67.3]	28.0	22.7	6.11	25.0
10 000.0	U673D109F6R3GS1C	0.770 x 3.150 [19.6 x 80.0]	23.0	19.0	7.20	21.0
12 000.0	U673D129F6R3GT1C	0.770 x 3.650 [19.6 x 92.7]	21.0	17.0	8.14	19.0
3300.0	U673D338F6R3HE1C	0.895 x 1.150 [22.7 x 29.2]	74.0	58.0	3.00	60.0
6800.0	U673D688F6R3HJ1C	0.895 x 1.650 [22.7 x 41.9]	38.0	39.0	4.73	41.0
10 000.0	U673D109F6R3HL1C	0.895 x 2.150 [22.7 x 54.6]	27.0	22.0	6.20	24.0
15 000.0	U673D159F6R3HP1C	0.895 x 2.650 [22.7 x 67.3]	21.0	17.4	7.62	19.0
18 000.0	U673D189F6R3HS1C	0.895 x 3.150 [22.7 x 80.0]	18.0	15.0	8.83	17.0
22 000.0	U673D229F6R3HT1C	0.895 x 3.650 [22.7 x 92.7]	15.8	13.3	10.10	15.0
4700.0	U673D478F6R3JE1C	1.020 x 1.150 [25.9 x 29.2]	60.0	48.0	3.60	50.0
10 000.0	U673D109F6R3JJ1C	1.020 x 1.650 [25.9 x 41.9]	32.0	26.0	5.54	28.0
15 000.0	U673D159F6R3JL1C	1.020 x 2.150 [25.9 x 54.6]	22.6	18.8	7.30	21.0
18 000.0	U673D189F6R3JP1C	1.020 x 2.650 [25.9 x 67.3]	18.0	15.2	8.81	17.0
22 000.0	U673D229F6R3JS1C	1.020 x 3.150 [25.9 x 80.0]	15.4	13.0	10.20	14.0
27 000.0	U673D279F6R3JT1C	1.020 x 3.650 [25.9 x 92.7]	13.4	11.5	11.60	13.0
7.5 WVDC AT 105 °C, SURGE = 10 V						
1800.0	U673D188F7R5GE1C	0.770 x 1.150 [19.6 x 29.2]	110.0	82.0	2.30	84.0
3900.0	U673D398F7R5GJ1C	0.770 x 1.650 [19.6 x 41.9]	55.0	41.0	3.70	52.0
5600.0	U673D568F7R5GL1C	0.770 x 2.150 [19.6 x 54.6]	38.0	29.0	4.93	31.0
8200.0	U673D828F7R5GP1C	0.770 x 2.650 [19.6 x 67.3]	29.5	22.8	6.10	25.0
10 000.0	U673D109F7R5GS1C	0.770 x 3.150 [19.6 x 80.0]	25.8	20.0	7.04	22.0
12 000.0	U673D129F7R5GT1C	0.770 x 3.650 [19.6 x 92.7]	22.0	17.4	8.06	19.0
3300.0	U673D338F7R5HE1C	0.895 x 1.150 [22.7 x 29.2]	76.0	58.4	2.97	61.0
5600.0	U673D568F7R5HJ1C	0.895 x 1.650 [22.7 x 41.9]	39.5	30.6	4.72	33.0
8200.0	U673D828F7R5HL1C	0.895 x 2.150 [22.7 x 54.6]	27.7	21.8	6.23	24.0
12 000.0	U673D129F7R5HP1C	0.895 x 2.650 [22.7 x 67.3]	22.0	17.6	7.58	20.0
15 000.0	U673D159F7R5HS1C	0.895 x 3.150 [22.7 x 80.0]	18.7	15.0	8.82	17.0
18 000.0	U673D189F7R5HT1C	0.895 x 3.650 [22.7 x 92.7]	16.4	13.5	9.97	15.0
3900.0	U673D398F7R5JE1C	1.020 x 1.150 [25.9 x 29.2]	62.0	48.0	3.55	50.0
8200.0	U673D828F7R5JJ1C	1.020 x 1.650 [25.9 x 41.9]	32.0	25.9	5.56	28.0
12 000.0	U673D129F7R5JL1C	1.020 x 2.150 [25.9 x 54.6]	23.5	19.0	7.22	21.0
18 000.0	U673D189F7R5JP1C	1.020 x 2.650 [25.9 x 67.3]	18.3	15.0	8.83	17.0
22 000.0	U673D229F7R5JS1C	1.020 x 3.150 [25.9 x 80.0]	15.8	13.0	10.20	15.0
27 000.0	U673D279F7R5JT1C	1.020 x 3.650 [25.9 x 92.7]	13.8	11.6	11.60	13.0

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**MAX. ESR AT + 25 °C (mΩ)**		**MAX. RIPPLE AT + 85 °C (A)**	**MAX. Z AT 100 kHz (mΩ)**
			120 Hz	**20 kHz to 40 kHz**	**20 kHz to 40 kHz**	
10 WVDC AT + 105 °C, SURGE = 12 V						
1800.0	U673D188F010GE1C	0.770 x 1.150 [19.6 x 29.2]	123.0	89.0	2.20	91.0
3300.0	U673D338F010GJ1C	0.770 x 1.650 [19.6 x 41.9]	60.0	44.0	3.56	46.0
5600.0	U673D568F010GL1C	0.770 x 2.150 [19.6 x 54.6]	41.0	30.0	4.79	32.0
6800.0	U673D688F010GP1C	0.770 x 2.650 [19.6 x 67.3]	31.0	24.0	5.93	26.0
8200.0	U673D828F010GS1C	0.770 x 3.150 [19.6 x 80.0]	26.0	20.0	7.02	22.0
10 000.0	U673D109F010GT1C	0.770 x 3.650 [19.6 x 92.7]	23.0	17.8	7.97	20.0
2700.0	U673D278F010HE1C	0.895 x 1.150 [22.7 x 29.2]	82.0	61.0	2.90	62.0
5600.0	U673D568F010HJ1C	0.895 x 1.650 [22.7 x 41.9]	42.0	32.0	4.61	34.0
8200.0	U673D828F010HL1C	0.895 x 2.150 [22.7 x 54.6]	29.6	22.0	6.11	24.0
10 000.0	U673D109F010HP1C	0.895 x 2.650 [22.7 x 67.3]	24.0	18.0	7.33	20.0
12 000.0	U673D129F010HS1C	0.895 x 3.150 [22.7 x 80.0]	19.9	15.8	8.63	17.0
15 000.0	U673D159F010HT1C	0.895 x 3.650 [22.7 x 92.7]	17.3	13.8	9.85	16.0
3900.0	U673D398F010JE1C	1.020 x 1.150 [25.9 x 29.2]	66.6	50.0	3.47	52.0
6800.0	U673D688F010JJ1C	1.020 x 1.650 [25.9 x 41.9]	34.0	26.7	5.48	29.0
12 000.0	U673D129F010JL1C	1.020 x 2.150 [25.9 x 54.6]	24.0	19.0	7.18	21.0
15 000.0	U673D159F010JP1C	1.020 x 2.650 [25.9 x 67.3]	19.2	15.0	8.72	17.0
18 000.0	U673D189F010JS1C	1.020 x 3.150 [25.9 x 80.0]	16.0	13.0	10.20	15.0
22 000.0	U673D229F010JT1C	1.020 x 3.650 [25.9 x 92.7]	14.3	11.8	11.50	14.0
12 WVDC AT + 105 °C, SURGE = 16 V						
1500.0	U673D158F012GE1C	0.770 x 1.150 [19.6 x 29.2]	119.0	83.0	2.26	85.0
3300.0	U673D338F012GJ1C	0.770 x 1.650 [19.6 x 41.9]	60.0	42.0	3.65	44.0
4700.0	U673D478F012GL1C	0.770 x 2.150 [19.6 x 54.6]	41.0	29.0	4.88	31.0
6800.0	U673D688F012GP1C	0.770 x 2.650 [19.6 x 67.3]	31.0	23.0	6.07	26.0
8200.0	U673D828F012GS1C	0.770 x 3.150 [19.6 x 80.0]	26.0	19.4	7.14	22.0
10 000.0	U673D109F012GT1C	0.770 x 3.650 [19.6 x 92.7]	23.0	17.0	8.11	20.0
2200.0	U673D228F012HE1C	0.895 x 1.150 [22.7 x 29.2]	83.0	60.0	2.93	62.0
4700.0	U673D478F012HJ1C	0.895 x 1.650 [22.7 x 41.9]	42.0	31.0	4.69	33.0
6800.0	U673D688F012HL1C	0.895 x 2.150 [22.7 x 54.6]	29.0	22.0	6.20	25.0
10000.0	U673D109F012HP1C	0.895 x 2.650 [22.7 x 67.3]	24.0	18.3	7.43	21.0
12 000.0	U673D129F012HS1C	0.895 x 3.150 [22.7 x 80.0]	19.7	15.0	8.82	18.0
15 000.0	U673D159F012HT1C	0.895 x 3.650 [22.7 x 92.7]	17.0	13.3	10.10	16.0
3300.0	U673D338F012JE1C	1.020 x 1.150 [25.9 x 29.2]	66.0	49.0	3.53	52.0
6800.0	U673D688F012JJ1C	1.020 x 1.650 [25.9 x 41.9]	34.0	26.0	5.54	29.0
10 000.0	U673D109F012JL1C	1.020 x 2.150 [25.9 x 54.6]	25.5	19.0	7.12	22.0
12 000.0	U673D129F012JP1C	1.020 x 2.650 [25.9 x 67.3]	19.7	15.0	8.75	18.0
18 000.0	U673D189F012JS1C	1.020 x 3.150 [25.9 x 80.0]	16.4	13.0	10.20	16.0
22 000.0	U673D229F012JT1C	1.020 x 3.650 [25.9 x 92.7]	14.6	11.8	11.50	15.0
16 WVDC AT 105°C, SURGE = 20 V						
1200.0	U673D128F016GE1C	0.770 x 1.150 [19.6 x 29.2]	129.0	83.0	2.24	85.0
2700.0	U673D278F016GJ1C	0.770 x 1.650 [19.6 x 41.9]	65.0	43.0	3.62	45.0
3900.0	U673D398F016GL1C	0.770 x 2.150 [19.6 x 54.6]	44.0	30.0	4.84	32.0
5600.0	U673D568F016GP1C	0.770 x 2.650 [19.6 x 67.3]	34.0	23.5	6.01	26.0
6800.0	U673D688F016GS1C	0.770 x 3.150 [19.6 x 80.0]	28.0	19.7	7.09	23.0
8200.0	U673D828F016GT1C	0.770 x 3.650 [19.6 x 92.7]	24.0	17.0	8.16	21.0
2200.0	U673D228F016HE1C	0.895 x 1.150 [22.7 x 29.2]	89.0	59.0	2.93	61.0
3900.0	U673D398F016HJ1C	0.895 x 1.650 [22.7 x 41.9]	45.0	31.6	4.64	34.0
5600.0	U673D568F016HL1C	0.895 x 2.150 [22.7 x 54.6]	31.6	22.4	6.14	25.0

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**MAX. ESR AT + 25 °C (mΩ)**		**MAX. RIPPLE AT + 85 °C (A)**	**MAX. Z AT 100 kHz (mΩ)**
			120 Hz	**20 kHz to 40 kHz**	**20 kHz to 40 kHz**	
16 WVDC AT 105 °C, SURGE = 20 V						
8200.0	U673D828F016HP1C	0.895 x 2.650 [22.7 x 67.3]	24.7	17.9	7.51	20.0
10 000.0	U673D109F016HS1C	0.895 x 3.150 [22.7 x 80.0]	20.7	15.2	8.79	18.0
12 000.0	U673D129F016HT1C	0.895 x 3.650 [22.7 x 92.7]	18.0	13.6	9.93	17.0
2700.0	U673D278F016JE1C	1.020 x 1.150 [25.9 x 29.2]	71.0	50.0	3.49	52.0
5600.0	U673D568F016JJ1C	1.020 x 1.650 [25.9 x 41.9]	36.7	26.7	5.48	29.0
8200.0	U673D828F016JL1C	1.020 x 2.150 [25.9 x 54.6]	26.0	19.2	7.18	22.0
12 000.0	U673D129F016JP1C	1.020 x 2.650 [25.9 x 67.3]	20.5	15.4	8.75	19.0
15 000.0	U673D159F016JS1C	1.020 x 3.150 [25.9 x 80.0]	17.4	13.3	10.20	17.0
18 000.0	U673D189F016JT1C	1.020 x 3.650 [25.9 x 92.7]	15.3	11.8	11.50	17.0
20 WVDC AT + 105 °C, SURGE = 30 V						
1000.0	U673D108F020GE1C	0.770 x 1.150 [19.6 x 29.2]	140.0	84.0	2.16	87.0
1800.0	U673D188F020GJ1C	0.770 x 1.650 [19.6 x 41.9]	67.0	44.0	3.56	47.0
2700.0	U673D278F020GL1C	0.770 x 2.150 [19.6 x 54.6]	45.0	30.0	4.81	33.0
3900.0	U673D398F020GP1C	0.770 x 2.650 [19.6 x 67.3]	34.9	23.9	6.96	27.0
4700.0	U673D478F020GS1C	0.770 x 3.150 [19.6 x 80.0]	28.7	19.9	7.05	24.0
5600.0	U673D568F020GT1C	0.770 x 3.650 [19.6 x 92.7]	24.6	17.0	8.09	21.0
1500.0	U673D158F020HE1C	0.895 x 1.150 [22.7 x 29.2]	94.0	59.0	2.86	62.0
3300.0	U673D338F020HJ1C	0.895 x 1.650 [22.7 x 41.9]	46.9	32.0	4.60	35.0
4700.0	U673D478F020HL1C	0.895 x 2.150 [22.7 x 54.6]	32.0	22.7	6.10	26.0
6800.0	U673D688F020HP1C	0.895 x 2.650 [22.7 x 67.3]	25.0	18.0	7.49	21.0
8200.0	U673D828F020HS1C	0.895 x 3.150 [22.7 x 80.0]	21.0	15.3	8.77	19.0
10 000.0	U673D109F020HT1C	0.895 x 3.650 [22.7 x 92.7]	18.0	13.6	9.93	18.0
2200.0	U673D228F020JE1C	1.020 x 1.150 [25.9 x 29.2]	72.0	49.0	3.48	52.0
4700.0	U673D478F020JJ1C	1.020 x 1.650 [25.9 x 41.9]	37.0	26.0	5.47	29.0
6800.0	U673D688F020JL1C	1.020 x 2.150 [25.9 x 54.6]	26.0	19.3	7.16	23.0
8200.0	U673D828F020JP1C	1.020 x 2.650 [25.9 x 67.3]	20.7	15.5	8.72	19.0
10 000.0	U673D109F020JS1C	1.020 x 3.150 [25.9 x 80.0]	17.9	13.6	10.10	18.0
12 000.0	U673D129F020JT1C	1.020 x 3.650 [25.9 x 92.7]	15.8	12.0	11.40	16.0
25 WVDC AT + 105 °C, SURGE = 35 V						
820.0	U673D827F025GE1C	0.770 x 1.150 [19.6 x 29.2]	143.0	85.0	2.23	88.0
1500.0	U673D158F025GJ1C	0.770 x 1.650 [19.6 x 41.9]	73.0	44.0	3.56	47.0
2200.0	U673D228F025GL1C	0.770 x 2.150 [19.6 x 54.6]	49.0	30.5	4.82	33.0
3300.0	U673D338F025GP1C	0.770 x 2.650 [19.6 x 67.3]	37.0	23.9	5.96	27.0
3900.0	U673D398F025GS1C	0.770 x 3.150 [19.6 x 80.0]	31.0	20.0	7.00	23.0
4700.0	U673D478F025GT1C	0.770 x 3.650 [19.6 x 92.7]	26.7	17.5	8.04	21.0
1200.0	U673D128F025HE1C	0.895 x 1.150 [22.7 x 29.2]	101.0	62.9	2.86	66.0
2700.0	U673D278F025HJ1C	0.895 x 1.650 [22.7 x 41.9]	50.0	32.0	4.61	35.0
3900.0	U673D398F025HL1C	0.895 x 2.150 [22.7 x 54.6]	35.0	22.9	6.08	26.0
4700.0	U673D478F025HP1C	0.895 x 2.650 [22.7 x 67.3]	27.0	18.0	7.47	21.0
6800.0	U673D688F025HS1C	0.895 x 3.150 [22.7 x 80.0]	22.7	15.4	8.74	19.0
8200.0	U673D828F025HT1C	0.895 x 3.650 [22.7 x 92.7]	19.6	13.6	9.93	17.0
1800.0	U673D188F025JE1C	1.020 x 1.150 [25.9 x 29.2]	79.0	51.0	3.45	53.0
3900.0	U673D398F025JJ1C	1.020 x 1.650 [25.9 x 41.9]	40.0	26.9	5.46	30.0
5600.0	U673D568F025JL1C	1.020 x 2.150 [25.9 x 54.6]	28.0	19.0	7.14	22.0
6800.0	U673D688F025JP1C	1.020 x 2.650 [25.9 x 67.3]	22.0	15.7	8.66	19.0
8200.0	U673D828F025JS1C	1.020 x 3.150 [25.9 x 80.0]	18.7	13.5	10.10	17.0
10 000.0	U673D109F025JT1C	1.020 x 3.650 [25.9 x 92.7]	16.4	12.0	11.40	15.0

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**MAX. ESR AT + 25 °C (mΩ)**		**MAX. RIPPLE AT + 85 °C (A)**	**MAX. Z AT 100 kHz (mΩ)**
			120 Hz	**20 kHz to 40 kHz**	**20 kHz to 40 kHz**	
30 WVDC AT + 105 °C, SURGE = 40 V						
820.0	U673D827F030GE1C	0.770 x 1.150 [19.6 x 29.2]	156.0	86.0	2.16	89.0
1500.0	U673D158F030GJ1C	0.770 x 1.650 [19.6 x 41.9]	80.0	47.0	3.45	50.0
2200.0	U673D228F030GL1C	0.770 x 2.150 [19.6 x 54.6]	53.0	32.0	4.68	35.0
3300.0	U673D338F030GP1C	0.770 x 2.650 [19.6 x 67.3]	40.0	25.0	5.81	28.0
3900.0	U673D398F030GS1C	0.770 x 3.150 [19.6 x 80.0]	34.0	21.0	6.82	24.0
4700.0	U673D478F030GT1C	0.770 x 3.650 [19.2 x 92.7]	28.8	18.4	7.84	22.0
1200.0	U673D128F030HE1C	0.895 x 1.150 [22.7 x 29.2]	106.0	64.0	2.83	67.0
2700.0	U673D278F030HJ1C	0.895 x 1.650 [22.7 x 41.9]	54.0	33.4	4.51	37.0
3900.0	U673D398F030HL1C	0.895 x 2.150 [22.7 x 54.6]	37.0	23.7	5.97	27.0
4700.0	U673D478F030HP1C	0.895 x 2.650 [22.7 x 67.3]	29.0	18.9	7.31	22.0
6800.0	U673D688F030HS1C	0.895 x 3.150 [22.7 x 80.0]	24.0	16.0	8.57	19.0
8200.0	U673D828F030HT1C	0.895 x 3.650 [22.7 x 92.7]	20.8	14.0	9.75	17.0
1800.0	U673D188F030JE1C	1.020 x 1.150 [25.9 x 29.2]	85.0	53.0	3.39	56.0
3300.0	U673D338F030JJ1C	1.020 x 1.650 [25.9 x 41.9]	43.7	28.0	5.33	31.0
4700.0	U673D478F030JL1C	1.020 x 2.150 [25.9 x 54.6]	30.0	20.0	7.04	23.0
6800.0	U673D688F030JP1C	1.020 x 2.650 [25.9 x 67.3]	23.7	16.2	8.53	20.0
8200.0	U673D828F030JS1C	1.020 x 3.150 [25.9 x 80.0]	19.8	13.8	9.95	17.0
10 000.0	U673D109F030JT1C	1.020 x 3.650 [25.9 x 92.7]	17.3	12.2	11.30	15.0
40 WVDC AT + 105 °C, SURGE = 55 V						
560.0	U673D567F040GE1C	0.770 x 1.150 [19.6 x 29.2]	191.0	86.0	2.22	89.0
1000.0	U673D108F040GJ1C	0.770 x 1.650 [19.6 x 41.9]	94.0	47.0	3.57	67.0
1500.0	U673D158F040GL1C	0.770 x 2.150 [19.6 x 54.6]	64.0	32.0	4.80	30.0
1800.0	U673D188F040GP1C	0.770 x 2.650 [19.6 x 67.3]	49.0	25.0	5.92	27.0
2200.0	U673D228F040GS1C	0.770 x 3.150 [19.6 x 80.0]	40.0	21.0	7.00	30.0
2700.0	U673D278F040GT1C	0.770 x 3.650 [19.6 x 92.7]	34.8	18.6	8.02	21.0
680.0	U673D687F040HE1C	0.895 x 1.150 [22.7 x 29.2]	130.0	64.0	3.00	62.0
1500.0	U673D158F040HJ1C	0.895 x 1.650 [22.7 x 41.9]	67.0	33.0	4.54	36.0
2200.0	U673D228F040HL1C	0.895 x 2.150 [22.7 x 54.6]	45.0	23.0	6.05	26.0
3300.0	U673D338F040HP1C	0.895 x 2.650 [22.7 x 67.3]	34.0	18.4	7.41	22.0
3900.0	U673D398F040HS1C	0.895 x 3.150 [22.7 x 80.0]	29.0	16.8	8.63	19.0
4700.0	U673D478F040HT1C	0.895 x 3.650 [22.7 x 92.7]	25.8	14.8	9.85	17.0
1000.0	U673D108F040JE1C	1.020 x 1.150 [25.9 x 29.2]	105.0	53.0	3.41	55.0
2200.0	U673D228F040JJ1C	1.020 x 1.650 [25.9 x 41.9]	51.7	28.0	5.42	30.0
2700.0	U673D278F040JL1C	1.020 x 2.150 [25.9 x 54.6]	36.0	20.0	7.49	23.0
3900.0	U673D398F040JP1C	1.020 x 2.650 [25.9 x 67.3]	28.7	16.0	8.90	19.0
4700.0	U673D478F040JS1C	1.020 x 3.150 [25.9 x 80.0]	23.8	13.0	10.60	17.0
5600.0	U673D568F040JT1C	1.020 x 3.650 [25.9 x 92.7]	20.3	12.0	11.40	16.0
50 WVDC AT + 105 °C, SURGE = 75 V						
390.0	U673D397F050GE1C	0.770 x 1.150 [19.6 x 29.2]	212.0	86.0	2.21	89.0
820.0	U673D827F050GJ1C	0.770 x 1.650 [19.6 x 41.9]	50.0	44.0	3.57	47.0
1200.0	U673D128F050GL1C	0.770 x 2.150 [19.6 x 54.6]	74.0	32.0	4.70	35.0
1500.0	U673D158F050GP1C	0.770 x 2.650 [19.6 x 67.3]	56.0	25.0	5.83	28.0
1800.0	U673D188F050GS1C	0.770 x 3.150 [19.6 x 80.0]	44.0	20.0	7.00	23.0
2200.0	U673D228F050GT1C	0.770 x 3.650 [19.6 x 92.7]	37.7	17.7	8.00	21.0
560.0	U673D567F050HE1C	0.895 x 1.150 [22.7 x 29.2]	145.0	59.0	2.87	62.0
1200.0	U673D128F050HJ1C	0.895 x 1.650 [22.7 x 41.9]	76.0	34.0	4.46	37.0
1800.0	U673D188F050HL1C	0.895 x 2.150 [22.7 x 54.6]	50.0	23.3	6.02	26.0

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**MAX. ESR AT + 25 °C (mΩ)**		**MAX. RIPPLE AT + 85 °C (A)**	**MAX. Z AT 100 kHz (mΩ)**
			120 Hz	**20 kHz to 40 kHz**	**20 kHz to 40 kHz**	
50 WVDC AT + 105 °C, SURGE = 75 V						
2200.0	U673D228F050HP1C	0.895 x 2.650 [22.7 x 67.3]	39.0	18.7	7.35	22.0
2700.0	U673D278F050HS1C	0.895 x 3.150 [22.7 x 80.0]	31.4	15.7	8.65	19.0
3300.0	U673D338F050HT1C	0.895 x 3.650 [22.7 x 92.7]	27.0	13.9	9.82	17.0
820.0	U673D828F050JE1C	1.020 x 1.150 [25.9 x 29.2]	112.0	51.4	3.45	54.0
1500.0	U673D158F050JJ1C	1.020 x 1.650 [25.9 x 41.9]	58.0	27.8	5.37	31.0
2200.0	U673D228F050JL1C	1.020 x 2.150 [25.9 x 54.6]	39.0	19.7	7.09	23.0
3300.0	U673D338F050JP1C	1.020 x 2.650 [25.9 x 67.3]	30.0	15.9	8.61	20.0
3900.0	U673D398F050JS1C	1.020 x 3.150 [25.9 x 80.0]	25.0	13.6	10.10	18.0
4700.0	U673D478F050JT1C	1.020 x 3.650 [25.9 x 92.7]	21.6	12.0	11.40	16.0
63 WVDC AT + 105 °C, SURGE = 85 V						
330.0	U673D337F063GE1C	0.770 x 1.150 [19.6 x 29.2]	236.0	89.0	2.13	93.0
680.0	U673D687F063GJ1C	0.770 x 1.650 [19.6 x 41.9]	117.0	47.0	3.44	50.0
1000.0	U673D108F063GL1C	0.770 x 2.150 [19.6 x 54.6]	79.0	33.3	4.61	36.0
1200.0	U673D128F063GP1C	0.770 x 2.650 [19.6 x 67.3]	63.0	27.0	5.61	30.0
1800.0	U673D188F063GS1C	0.770 x 3.150 [19.6 x 80.0]	49.9	22.0	6.71	25.0
2200.0	U673D228F063GT1C	0.770 x 3.650 [19.6 x 92.7]	41.7	18.9	7.74	22.0
560.0	U673D567F063HE1C	0.895 x 1.150 [22.7 x 29.2]	159.0	66.0	2.79	69.0
1000.0	U673D108F063HJ1C	0.895 x 1.650 [22.7 x 41.9]	82.0	35.4	4.38	38.0
1500.0	U673D158F063HL1C	0.895 x 2.150 [22.7 x 54.6]	54.0	24.5	5.87	28.0
2200.0	U673D228F063HP1C	0.895 x 2.650 [22.7 x 67.3]	41.0	19.3	7.24	22.0
2700.0	U673D278F063HS1C	0.895 x 3.150 [22.7 x 80.0]	34.6	16.6	8.42	20.0
3300.0	U673D338F063HT1C	0.895 x 3.650 [22.7 x 92.7]	29.0	14.5	9.61	18.0
680.0	U673D687F063JE1C	1.020 x 1.150 [25.9 x 29.2]	122.0	51.0	3.70	54.0
1500.0	U673D158F063JJ1C	1.020 x 1.650 [25.9 x 41.9]	63.0	28.0	5.54	31.0
2200.0	U673D228F063JL1C	1.020 x 2.150 [25.9 x 54.6]	42.0	20.6	6.93	24.0
2700.0	U673D278F063JP1C	1.020 x 2.650 [25.9 x 67.3]	32.9	16.5	8.45	20.0
3900.0	U673D398F063JS1C	1.020 x 3.150 [25.9 x 80.0]	27.0	14.0	9.85	18.0
4700.0	U673D478F063JT1C	1.020 x 3.650 [25.9 x 92.7]	23.3	12.4	11.20	16.0
75 WVDC AT + 105 °C, SURGE = 100 V						
270.0	U673D277F075GE1C	0.770 x 1.150 [19.6 x 29.2]	311.0	141.0	1.73	145.0
560.0	U673D567F075GJ1C	0.770 x 1.650 [19.6 x 41.9]	150.0	70.0	2.84	73.0
820.0	U673D827F075GL1C	0.770 x 2.150 [19.6 x 54.6]	101.0	48.0	3.84	51.0
1200.0	U673D128F075GP1C	0.770 x 2.650 [19.6 x 67.3]	77.0	37.3	4.77	40.0
1500.0	U673D158F075GS1C	0.770 x 3.150 [19.6 x 80.0]	63.0	30.7	5.68	34.0
1800.0	U673D188F075GT1C	0.770 x 3.650 [19.6 x 92.7]	53.0	26.4	6.55	30.0
390.0	U673D397F075HE1C	0.895 x 1.150 [22.7 x 29.2]	214.0	100.0	2.27	104.0
820.0	U673D827F075HJ1C	0.895 x 1.650 [22.7 x 41.9]	104.0	50.0	3.67	53.0
1200.0	U673D128F075HL1C	0.895 x 2.150 [22.7 x 54.6]	73.0	36.0	4.83	39.0
1800.0	U673D188F075HP1C	0.895 x 2.650 [22.7 x 67.3]	54.0	27.5	6.06	31.0
2200.0	U673D228F075HS1C	0.895 x 3.150 [22.7 x 80.0]	45.0	23.0	7.12	26.0
2700.0	U673D278F075HT1C	0.895 x 3.650 [22.7 x 92.7]	37.0	19.8	8.23	23.0
560.0	U673D567F075JE1C	1.020 x 1.150 [25.9 x 29.2]	159.0	78.0	2.81	81.0
1200.0	U673D128F075JJ1C	1.020 x 1.650 [25.9 x 41.9]	82.0	41.4	4.40	44.0
1800.0	U673D188F075JL1C	1.020 x 2.150 [25.9 x 54.6]	53.9	28.0	5.95	30.0
2200.0	U673D228F075JP1C	1.020 x 2.650 [25.9 x 67.3]	41.8	22.2	7.29	25.0
2700.0	U673D278F075JS1C	1.020 x 3.150 [25.9 x 80.0]	33.7	18.5	8.60	22.0
3300.0	U673D338F075JT1C	1.020 x 3.650 [25.9 x 92.7]	29.0	16.2	9.80	19.0

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**MAX. ESR AT + 25 °C (mΩ)**		**MAX. RIPPLE AT + 85 °C (A)**	**MAX. Z AT 100 kHz (mΩ)**
			120 Hz	**20 kHz to 40 kHz**	**20 kHz to 40 kHz**	
100 WVDC AT + 105 °C, SURGE = 125 V						
150.0	U673D157F100GE1C	0.770 x 1.150 [19.6 x 29.2]	698.0	324.0	1.14	326.0
270.0	U673D277F100GJ1C	0.770 x 1.650 [19.6 x 41.9]	329.0	154.0	1.92	156.0
390.0	U673D397F100GL1C	0.770 x 2.150 [19.6 x 54.6]	221.0	104.0	2.60	106.0
560.0	U673D567F100GP1C	0.770 x 2.650 [19.6 x 67.3]	164.0	78.0	3.39	80.0
680.0	U673D687F100GS1C	0.770 x 3.150 [19.6 x 80.0]	131.0	63.0	3.96	65.0
820.0	U673D827F100GT1C	0.770 x 3.650 [19.6 x 92.7]	110.0	53.0	4.60	54.0
220.0	U673D227F100HE1C	0.895 x 1.150 [22.7 x 29.2]	452.0	212.0	1.55	215.0
390.0	U673D397F100HJ1C	0.895 x 1.650 [22.7 x 41.9]	216.0	103.0	2.57	106.0
680.0	U673D687F100HL1C	0.895 x 2.150 [22.7 x 54.6]	143.0	69.0	3.49	71.0
820.0	U673D827F100HP1C	0.895 x 2.650 [22.7 x 67.3]	107.0	52.0	4.37	53.0
1000.0	U673D108F100HS1C	0.895 x 3.150 [22.7 x 80.0]	89.0	44.0	5.15	45.0
1200.0	U673D128F100HT1C	0.895 x 3.650 [22.7 x 92.7]	76.0	38.0	5.93	39.0
270.0	U673D277F100JE1C	1.020 x 1.150 [25.9 x 29.2]	337.0	162.0	1.95	163.0
560.0	U673D567F100JJ1C	1.020 x 1.650 [25.9 x 41.9]	163.0	79.0	3.17	81.0
820.0	U673D827F100JL1C	1.020 x 2.150 [25.9 x 54.6]	109.0	54.0	4.27	55.0
1200.0	U673D128F100JP1C	1.020 x 2.650 [25.9 x 67.3]	83.0	42.0	5.28	43.0
1500.0	U673D158F100JS1C	1.020 x 3.150 [25.9 x 80.0]	67.0	34.0	6.29	35.0
1800.0	U673D188F100JT1C	1.020 x 3.650 [25.9 x 92.7]	57.0	29.5	7.26	31.0
150 WVDC AT + 105 °C, SURGE = 200 V						
56.0	U673D566F150GE1C	0.770 x 1.150 [19.6 x 29.2]	1733.0	881.0	0.694	895.0
100.0	U673D107F150GJ1C	0.770 x 1.650 [19.6 x 41.9]	886.0	450.0	1.12	460.0
180.0	U673D187F150GL1C	0.770 x 2.150 [19.6 x 54.6]	569.0	290.0	1.56	297.0
220.0	U673D227F150GP1C	0.770 x 2.650 [19.6 x 67.3]	419.0	215.0	1.99	220.0
330.0	U673D337F150GS1C	0.770 x 3.150 [19.6 x 80.0]	333.0	170.0	2.41	175.0
390.0	U673D397F150GT1C	0.770 x 3.650 [19.6 x 92.7]	276.0	141.0	2.83	148.0
82.0	U673D826F150HE1C	0.895 x 1.150 [22.7 x 29.2]	1152.0	588.0	0.936	592.0
180.0	U673D187F150HL1C	0.895 x 1.650 [22.7 x 41.9]	579.0	296.0	1.51	300.0
270.0	U673D277F150HL1C	0.895 x 2.150 [22.7 x 54.6]	376.0	193.0	2.09	198.0
390.0	U673D397F150HP1C	0.895 x 2.650 [22.7 x 67.3]	279.0	143.0	2.66	148.0
470.0	U673D477F150HT1C	0.895 x 3.150 [22.7 x 80.0]	222.0	115.0	3.19	120.0
560.0	U673D567F150HT1C	0.895 x 3.650 [22.7 x 92.7]	185.0	96.0	3.74	100.0

ORIGINAL RATINGS						
CAPACITANCE (µF)	**PART NUMBER [1]**	**CASE CODE**	**MAX. ESR AT + 25 °C (mΩ)**		**MAX. RIPPLE AT + 85 °C (A)**	**MAX. IMPEDANCE AT 100 kHz (mΩ)**
			120 Hz	**20 kHz**	**20 kHz to 100 kHz**	
6.3 WVDC at 105 °C, SURGE = 9 V						
1500.0	U673D158H6R3GE1C	GE	98.0	69.0	2.48	70.0
2200.0	U673D228H6R3HE1C	HE	71.0	51.0	3.18	52.0
2700.0	U673D278H6R3JE1C	JE	62.0	47.0	3.60	49.0
3900.0	U673D398H6R3HJ1C	HJ	41.0	30.0	4.76	31.0
5600.0	U673D568H6R3JJ1C	JJ	33.0	25.0	5.66	27.0
6800.0	U673D688H6R3GS1C	GS	23.0	18.0	7.40	19.0
8200.0	U673D828H6R3JL1C	JL	23.0	18.0	7.41	20.0
10 000.0	U673D109H6R3HS1C	HS	19.0	15.0	8.85	17.0
12 000.0	U673D129H6R3JP1C	JP	19.0	15.0	8.86	17.0
15 000.0	U673D159H6R3JS1C	JS	15.0	13.0	10.20	14.0
18 000.0	U673D189H6R3JT1C	JT	14.0	12.0	11.40	13.0

Note

[1] For applications requiring single ended, 3 lead capacitors, change the Part Number U673D to Part Number U674D. Type U674D is only available in terminal style “A”.

ORIGINAL RATINGS						
CAPACITANCE (µF)	PART NUMBER [1]	CASE CODE	MAX. ESR AT + 25 °C (mΩ)		MAX. RIPPLE AT + 85 °C (A)	MAX. IMPEDANCE AT 100 kHz (mΩ)
			120 Hz	20 kHz	20 kHz to 100 kHz	
7.5 WVDC AT + 105 °C, SURGE = 10 V						
1200.0	U673D128H7R5GE1C	GE	115.0	76.0	2.36	78.0
1800.0	U673D188H7R5HE1C	HE	80.0	55.0	3.06	56.0
2700.0	U673D278H7R5JE1C	JE	62.0	45.0	3.68	46.0
3900.0	U673D398H7R5HJ1C	HJ	39.0	28.0	4.92	29.0
4700.0	U673D478H7R5JJ1C	JJ	35.0	25.0	5.66	26.0
5600.0	U673D568H7R5HL1C	HL	28.0	20.0	6.50	22.0
6800.0	U673D688H7R5HP1C	HP	23.0	17.0	7.70	19.0
8200.0	U673D828H7R5JL1C	JL	23.0	18.0	7.41	19.0
10 000.0	U673D109H7R5JP1C	JP	19.0	15.0	8.86	16.0
12 000.0	U673D129H7R5JS1C	JS	17.0	13.0	10.20	14.0
15 000.0	U673D159H7R5JT1C	JT	14.0	12.0	11.40	13.0
10 WVDC AT + 105 °C, SURGE = 14 V						
1000.0	U673D108H010GE1C	GE	123.0	76.0	2.36	77.0
1500.0	U673D158H010HE1C	HE	89.0	56.0	3.03	58.0
2200.0	U673D228H010JE1C	JE	67.0	45.0	3.68	47.0
3300.0	U673D338H010HJ1C	HJ	43.0	29.0	4.84	30.0
3900.0	U673D398H010GP1C	GP	31.0	20.0	6.51	23.0
4700.0	U673D478H010JJ1C	JJ	35.0	24.0	5.78	26.0
5600.0	U673D568H010HP1C	HP	22.0	15.0	8.20	18.0
6800.0	U673D688H010JL1C	JL	23.0	16.0	7.86	19.0
8200.0	U673D828H010JP1C	JP	19.0	14.0	9.17	17.0
10 000.0	U673D109H010JS1C	JS	16.0	12.0	10.60	15.0
12 000.0	U673D129H010JT1C	JT	14.0	11.0	11.90	14.0
12 WVDC AT + 105 °C, SURGE = 16 V						
1000.0	U673D108H012GE1C	GE	126.0	76.0	2.36	79.0
1500.0	U673D158H012HE1C	HE	88.0	55.0	3.06	58.0
2200.0	U673D228H012JE1C	JE	68.0	43.0	3.77	45.0
2700.0	U673D278H012GL1C	GL	41.0	25.0	5.31	27.0
3300.0	U673D338H012HJ1C	HJ	45.0	29.0	4.84	31.0
3900.0	U673D398H012JJ1C	JJ	38.0	25.0	5.66	28.0
4700.0	U673D478H012HL1C	HL	30.0	19.0	6.67	21.0
5600.0	U673D568H012JL1C	JL	24.0	17.0	7.62	21.0
6800.0	U673D688H012HS1C	HS	19.0	13.0	9.51	17.0
8200.0	U673D828H012JP1C	JP	19.0	14.0	9.17	18.0
10 000.0	U673D109H012JS1C	JS	16.0	12.0	10.60	16.0
12 000.0	U673D129H012JT1C	JT	14.0	10.0	12.40	14.0
15 WVDC AT + 105 °C, SURGE = 20 V						
820.0	U673D827H015GE1C	GE	142.0	78.0	2.33	80.0
1500.0	U673D158H015HE1C	HE	86.0	51.0	3.18	53.0
1800.0	U673D188H015JE1C	JE	74.0	46.0	3.64	48.0
2700.0	U673D278H015HJ1C	HJ	47.0	28.0	4.92	30.0
3300.0	U673D338H015GP1C	GP	34.0	20.0	6.51	23.0
3900.0	U673D398H015JJ1C	JJ	37.0	24.0	5.78	27.0
5600.0	U673D568H015JL1C	JL	25.0	17.0	7.62	20.0
6800.0	U673D688H015JP1C	JP	20.0	13.0	9.51	17.0
8200.0	U673D828H015JS1C	JS	17.0	12.0	10.60	16.0
12 000.0	U673D129H015JT1C	JT	15.0	10.0	12.40	14.0

Note

[1] For applications requiring single ended, 3 lead capacitors, change the Part Number U673D to Part Number U674D. Type U674D is only available in terminal style “A”.

ORIGINAL RATINGS						
CAPACITANCE (µF)	PART NUMBER [1]	CASE CODE	MAX. ESR AT + 25 °C (mΩ)		MAX. RIPPLE AT + 85 °C (A)	MAX. IMPEDANCE AT 100 kHz (mΩ)
			120 Hz	20 kHz	20 kHz to 100 kHz	
20 WVDC AT + 105 °C, SURGE = 30 V						
680.0	U673D687H020GE1C	GE	131.0	72.0	2.42	75.0
1000.0	U673D108H020HE1C	HE	86.0	50.0	3.21	54.0
1500.0	U673D158H020JE1C	JE	71.0	43.0	3.68	45.0
2200.0	U673D228H020HJ1C	HJ	44.0	26.0	5.11	28.0
2700.0	U673D278H020JJ1C	JJ	37.0	23.0	5.90	25.0
3300.0	U673D338H020HL1C	HL	30.0	19.0	6.67	21.0
3900.0	U673D398H020GT1C	GT	24.0	15.0	8.69	18.0
4700.0	U673D478H020JL1C	JL	26.0	17.0	7.62	20.0
5600.0	U673D568H020JP1C	JP	20.0	14.0	9.17	17.0
6800.0	U673D688H020JS1C	JS	17.0	12.0	10.60	16.0
8200.0	U673D828H020JT1C	JT	15.0	10.0	12.40	14.0
25 WVDC AT + 105 °C, SURGE = 35 V						
560.0	U673D567H025GE1C	GE	144.0	67.0	2.51	70.0
820.0	U673D827H025HE1C	HE	103.0	51.0	3.18	55.0
1200.0	U673D128H025JE1C	JE	80.0	42.0	3.81	44.0
1500.0	U673D158H025GL1C	GL	49.0	24.0	5.42	26.0
1800.0	U673D188H025HJ1C	HJ	52.0	27.0	5.01	30.0
2200.0	U673D228H025JJ1C	JJ	41.0	23.0	5.90	25.0
2700.0	U673D278H025GS1C	GS	31.0	16.0	7.85	19.0
3300.0	U673D338H025JL1C	JL	28.0	16.0	7.86	19.0
3900.0	U673D398H025HS1C	HS	23.0	13.0	9.51	16.0
4700.0	U673D478H025JP1C	JP	22.0	13.0	9.51	16.0
5600.0	U673D568H025JS1C	JS	19.0	11.0	11.10	14.0
6800.0	U673D688H025JT1C	JT	16.0	10.0	12.40	13.0
40 WVDC AT + 105 °C, SURGE = 55 V						
330.0	U673D337H040GE1C	GE	199.0	69.0	2.48	71.0
560.0	U673D567H040HE1C	HE	135.0	50.0	3.21	54.0
680.0	U673D687H040JE1C	JE	110.0	44.0	3.72	47.0
1000.0	U673D108H040HJ1C	HJ	67.0	27.0	5.01	30.0
1200.0	U673D128H040GP1C	GP	51.0	20.0	6.51	22.0
1500.0	U673D158H040JJ1C	JJ	55.0	23.0	5.90	26.0
1800.0	U673D188H040GS1C	GS	41.0	16.0	7.85	19.0
2200.0	U673D228H040JL1C	JL	38.0	17.0	7.62	19.0
2700.0	U673D278H040JP1C	JP	29.0	14.0	9.17	17.0
3300.0	U673D338H040JS1C	JS	24.0	12.0	10.60	15.0
3900.0	U673D398H040JT1C	JT	21.0	10.0	12.40	13.0
50 WVDC AT + 105 °C, SURGE = 75 V						
270.0	U673D277H050GE1C	GE	249.0	70.0	2.46	72.0
390.0	U673D397H050HE1C	HE	170.0	52.0	3.15	54.0
470.0	U673D477H050GJ1C	GJ	122.0	36.0	3.96	38.0
560.0	U673D567H050JE1C	JE	129.0	43.0	3.77	45.0
820.0	U673D827H050HJ1C	HJ	85.0	27.0	5.01	30.0
1000.0	U673D108H050JJ1C	JJ	65.0	23.0	5.90	25.0
1200.0	U673D128H050HL1C	HL	57.0	19.0	6.67	21.0
1500.0	U673D158H050JL1C	JL	44.0	17.0	7.62	20.0
1800.0	U673D188H050HS1C	HS	36.0	13.0	9.51	16.0
2200.0	U673D228H050JP1C	JP	34.0	14.0	9.17	17.0
2700.0	U673D278H050JS1C	JS	28.0	12.0	10.60	15.0
3300.0	U673D338H050JT1C	JT	24.0	10.0	12.40	13.0

Note

[1] For applications requiring single ended, 3 lead capacitors, change the Part Number U673D to Part Number U674D. Type U674D is only available in terminal style “A”.

ORIGINAL RATINGS

CAPACITANCE (µF)	PART NUMBER (1)	CASE CODE	MAX. ESR AT + 25 °C (mΩ)		MAX. RIPPLE AT + 85 °C (A)	MAX. IMPEDANCE AT 100 kHz (mΩ)
			120 Hz	20 kHz	20 kHz to 100 kHz	
60 WVDC AT + 105 °C, SURGE = 85 V						
180.0	U673D187H060GE1C	GE	341.0	73.0	2.41	75.0
270.0	U673D277H060HE1C	HE	215.0	51.0	3.18	54.0
330.0	U673D337H060GJ1C	GJ	167.0	38.0	3.85	40.0
390.0	U673D397H060JE1C	JE	164.0	43.0	3.77	45.0
560.0	U673D567H060HJ1C	HJ	106.0	27.0	5.01	29.0
680.0	U673D687H060GP1C	GP	84.0	21.0	6.35	23.0
820.0	U673D827H060JJ1C	JJ	82.0	23.0	5.90	26.0
1000.0	U673D108H060GT1C	GT	57.0	15.0	8.69	18.0
1200.0	U673D128H060JL1C	JL	55.0	17.0	7.62	20.0
1500.0	U673D158H060JP1C	JP	42.0	13.0	9.51	17.0
1800.0	U673D188H060JS1C	JS	35.0	12.0	10.60	16.0
2200.0	U673D228H060JT1C	JT	30.0	10.0	12.40	14.0
75 WVDC AT + 105 °C, SURGE = 100 V						
120.0	U673D127H075GE1C	GE	600.0	169.0	1.58	170.0
180.0	U673D187H075HE1C	HE	399.0	116.0	2.10	117.0
220.0	U673D227H075JE1C	JE	300.0	92.0	2.57	93.0
330.0	U673D337H075HJ1C	HJ	196.0	59.0	3.39	60.0
470.0	U673D477H075JJ1C	JJ	145.0	46.0	4.17	47.0
560.0	U673D567H075HL1C	HL	131.0	40.0	4.59	41.0
680.0	U673D687H075JL1C	JL	98.0	32.0	4.02	31.0
820.0	U673D827H075HS1C	HS	80.0	26.0	6.72	28.0
1000.0	U673D108H075JP1C	JP	73.0	24.0	7.00	26.0
1200.0	U673D128H075JS1C	JS	59.0	20.0	8.27	22.0
1500.0	U673D158H075JT1C	JT	50.0	18.0	9.30	20.0
100 WVDC AT + 105 °C, SURGE = 125 V						
68.0	U673D686H100GE1C	GE	992.0	292.0	1.20	295.0
120.0	U673D127H100HE1C	HE	602.0	182.0	1.68	185.0
150.0	U673D157H100JE1C	JE	490.0	150.0	2.01	155.0
220.0	U673D227H100HJ1C	HJ	294.0	90.0	2.74	91.0
270.0	U673D277H100GP1C	GP	240.0	73.0	3.40	74.0
330.0	U673D337H100JJ1C	JJ	239.0	75.0	3.27	76.0
390.0	U673D397H100GT1C	GT	161.0	50.0	4.76	51.0
470.0	U673D477H100JL1C	JL	159.0	51.0	4.40	52.0
560.0	U673D567H100JP1C	JP	120.0	39.0	5.49	40.0
680.0	U673D687H100JS1C	JS	96.0	32.0	6.53	33.0
820.0	U673D827H100JT1C	JT	81.0	28.0	7.46	29.0
150 WVDC AT + 105 °C, SURGE = 200 V						
56.0	U673D566H150GE1C	GE	1733.0	881.0	0.694	895.0
82.0	U673D826H150HE1C	HE	1152.0	588.0	0.936	592.0
100.0	U673D107H150GJ1C	GJ	886.0	450.0	1.12	460.0
150.0	U673D157H150GL1C	GL	569.0	290.0	1.56	297.0
220.0	U673D227H150HL1C	HL	376.0	193.0	2.09	198.0
330.0	U673D337H150JL1C	JL	275.0	142.0	2.64	148.0
470.0	U673D477H150JP1C	JP	202.0	105.0	3.35	108.0
470.0	U673D477H150HT1C	HT	185.0	96.0	3.74	100.0
560.0	U673D567H150JS1C	JS	163.0	84.0	4.03	88.0
680.0	U673D687H150JT1C	JT	137.0	71.0	4.69	74.0

Note

(1) For applications requiring single ended, 3 lead capacitors, change the Part Number U673D to Part Number U674D. Type U674D is only available in terminal style “A”.

ORIGINAL RATINGS						
CAPACITANCE (µF)	PART NUMBER [1]	CASE CODE	MAX. ESR AT + 25 °C (mΩ)		MAX. RIPPLE AT + 85 °C (A)	MAX. IMPEDANCE AT 100 kHz (mΩ)
			120 Hz	20 kHz	20 kHz to 100 kHz	
200 WVDC AT + 105 °C, SURGE = 250 V						
33.0	U673D336H200GE1C	GE	2290.0	1000.0	0.651	1040.0
56.0	U673D566H200HE1C	HE	1510.0	670.0	0.878	680.0
82.0	U673D826H200JE1C	JE	1090.0	486.0	1.13	492.0
150.0	U673D157H200JJ1C	JJ	538.0	240.0	1.83	246.0
220.0	U673D227H200JL1C	JL	356.0	160.0	2.49	168.0
330.0	U673D337H200HT1C	HT	242.0	108.0	3.53	112.0
390.0	U673D397H200JS1C	JS	214.0	97.0	3.76	101.0
470.0	U673D477H200JT1C	JT	179.0	80.0	4.42	84.0
250 WVDC AT + 105 °C SURGE = 300 V						
22.0	U673D226H250GE1C	GE	2980.0	780.0	0.738	790.0
47.0	U673D476H250GJ1C	GJ	1310.0	370.0	1.24	380.0
100.0	U673D107H250GP1C	GP	740.0	195.0	2.09	200.0
150.0	U673D157H250HP1C	HP	467.0	125.0	2.84	130.0
220.0	U673D227H250JP1C	JP	343.0	94.0	3.54	98.0
270.0	U673D277H250JS1C	JS	270.0	75.0	4.27	79.0
330.0	U673D337H250JT1C	JT	222.0	61.0	5.05	65.0

Note

[1] For applications requiring single ended, 3 lead capacitors, change the Part Number U673D to Part Number U674D. Type U674D is only available in terminal style “A”.

Aluminum Capacitors
+ 125 °C, Miniature, Radial Lead

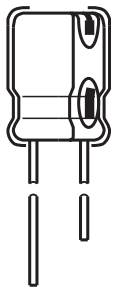


Fig.1 Component outline

FEATURES

- + 125 °C performance
- Suitable for tantalum foil replacement applications
- Low DC leakage currents
- Very stable, long life
- Case sizes through 0.709" x 1.417" [18.0 mm x 36.0 mm]
- Optional third lead on diameters ≥ 0.492" [12.5 mm]

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.236" x 0.433" [6.0 x 11.0] to 0.709" x 1.417" [18.0 x 36.0]
Operating temperature	- 40 °C to + 125 °C
Rated capacitance range, C_R	1.0 µF to 6800 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 63 WVDC
Termination	2 and 3 radial leads
Life validation test at 125 °C	2000 hours: Δ CAP ≤ 15 % (6.3WVDC to 10 WVDC), ≤ 10 % (16 WVDC to 63 WVDC) from initial measurement. Δ DF ≤ 1.25 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at 105 °C	500 hours: Δ CAP ≤ 12 % from initial measurement. Δ DF ≤ 1.25 x initial specified limit. Δ DCL ≤ 2.0 x initial specified limit.
DC leakage current at 25 °C	I = 0.01 CV I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE				
Ambient Temperature	**Multipliers**			
+ 125 °C	0.4			
+ 105 °C	1.0			
+ 85 °C	1.41			
+ 75 °C	1.58			
≤ + 65 °C	1.73			
FREQUENCY (Hz)				
Frequency (Hz)	**50 - 60**	**100 - 120**	**300 - 400**	**1K and up**
Multipliers	0.85	1.00	1.05	1.10
	0.80	1.00	1.30	1.40

LOW TEMPERATURE PERFORMANCE

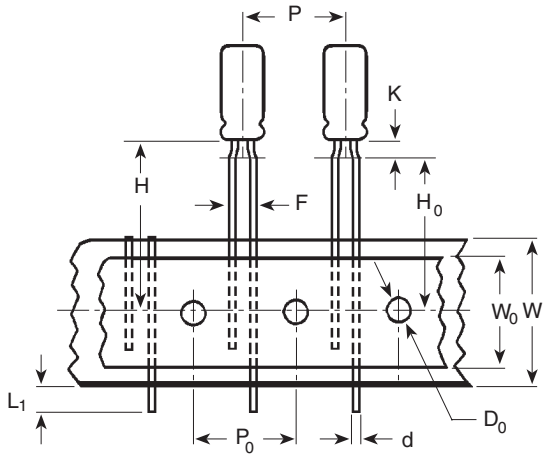
CAPACITANCE RATIO $C_{-55\,°C}/C_{+25\,°C}$ MINIMUM AT 120 Hz	
Rated Voltage (WVDC)	**Capacitance Remaining**
6.3 - 10	75 %
16 - 25	80 %
36 - 63	85 %
ESR RATIO $ESR_{-55\,°C}/ESR_{+25\,°C}$ MAXIMUM AT 120 HZ	
Rated Voltage (WVDC)	**Multiplier**
6.3 - 10	35
16 - 25	30
36 - 63	25

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL		STYLES 2 AND 4		STYLES 3 AND 5		LEAD SPACING		LEAD DIAMETER	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)	S ± 0.024 [0.60]	T ± 0.020 [0.50]	Nominal	AWG No.
BB	0.315 [8.0]	0.472 [12.0]	0.335 [8.5]	0.512 [13.0]	0.335 [8.5]	0.551 [14.0]	0.138 [3.5]	N/A	0.025 [0.63]	22
BD	0.315 [8.0]	0.630 [16.0]	0.335 [8.5]	0.669 [17.0]	0.335 [8.5]	0.709 [18.0]	0.138 [3.5]	N/A	0.025 [0.63]	22
CC	0.394 [10.0]	0.512 [13.0]	0.413 [10.5]	0.563 [14.3]	0.413 [10.5]	0.630 [16.0]	0.197 [5.0]	N/A	0.025 [0.63]	22
CG	0.394 [10.0]	0.787 [20.0]	0.413 [10.5]	0.846 [21.5]	0.413 [10.5]	0.906 [23.0]	0.197 [5.0]	N/A	0.025 [0.63]	22
DG	0.492 [12.5]	0.787 [20.0]	0.512 [13.0]	0.846 [21.5]	0.512 [13.0]	0.906 [23.0]	0.197 [5.0]	0.098 [2.5]	0.028 [0.71]	20
DK	0.492 [12.5]	0.984 [25.0]	0.512 [13.0]	1.043 [26.5]	0.512 [13.0]	1.142 [29.0]	0.197 [5.0]	0.098 [2.5]	0.032 [0.81]	20
EN	0.630 [16.0]	1.260 [32.0]	0.650 [16.5]	1.319 [33.5]	0.650 [16.5]	1.417 [36.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
ER	0.630 [16.0]	1.417 [36.0]	0.650 [16.5]	1.476 [37.5]	0.650 [16.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20
FR	0.709 [18.0]	1.417 [36.0]	0.728 [18.5]	1.476 [37.5]	0.728 [18.5]	1.575 [40.0]	0.295 [7.5]	0.150 [3.8]	0.032 [0.81]	20

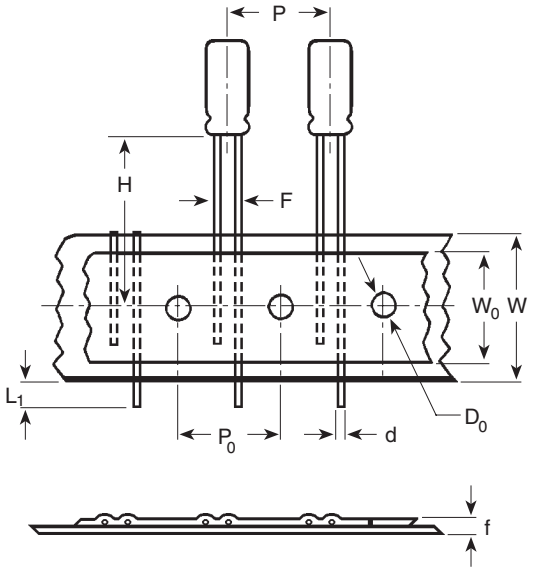
DIMENSIONS in inches [millimeters] **AND AVAILABLE FORMS**

Formed Leads



DIMENSIONS in inches [millimeters] **AND PACKAGING QUANTITIES**		
CASE SIZE	**F LEAD SPACING**	**STD. QTY/REEL**
0.236 x 0.433 [6.0 x 11.0]	0.197 [5.0]	800
0.315 x 0.472 [8.0 x 12.0]	0.197 [5.0]	700

Unformed (Straight) Leads



DIMENSIONS in inches [millimeters] **AND PACKAGING QUANTITIES**		
CASE SIZE	**F LEAD SPACING**	**STD. QTY/REEL**
0.236 x 0.433 [6.0 x 11.0]	0.098 [2.5] (1)	800
0.315 x 0.472 [8.0 x 12.0]	0.140 [3.5] (1)	700
0.394 x 0.512 [10.0 x 13.0]	0.197 [5.0]	500
0.394 x 0.630 [10.0 x 16.0]	0.197 [5.0]	500
0.394 x 0.787 [10.0 x 20.0]	0.197 [5.0]	500

Note (1) Available as special order.

DIMENSIONS in inches [millimeters]					
ITEM	**CASE SIZE (Diameter x Length)**				
	0.236 x 0.433 [6.0 x 11.0]	**0.315 x 0.472 [8.0 x 12.0]**	**0.394 x 0.512 [10.0 x 13.0]**	**0.394 x 0.630 [10.0 x 16.0]**	**0.394 x 0.787 [10.0 x 20.0]**
d - Lead-wire diameter	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]	0.025 [0.63]
P - Pitch of component	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
P_0 - Feed hole pitch	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]	0.500 [12.7]
F - Lead-to-lead distance	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]	0.197 [5.0]
K - Clinch height	0.098 [2.5]	0.157 [4.0]	N/A	N/A	N/A
H - Height of component from tape center	0.728 [18.5]	0.787 [20.0]	0.906 [23.0]	0.906 [23.0]	0.906 [23.0]
H_0 - Lead-wire clinch height	0.630 [16.0]	0.630 [16.0]	N/A	N/A	N/A
W - Tape width	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]	0.709 [18.0]
W_0 - Hold down tape width	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]	0.591 [15.0]
D_0 - Feed hole diameter	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]	0.157 [4.0]
t - Total tape thickness	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]	0.028 [0.7]
L_1 -Maximum lead protrusion	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]	0.118 [3.0]

Note
Positive leader is standard. Negative leader is available by special order.

ORDERING EXAMPLE

Electrolytic capacitor 510DX series: 510DX 227 M 050 DG 2 D

DESCRIPTION	
CODE	**EXPLANATION**
510DX	product type
227	capacitance value (220 µF)
M	tolerance (M = ± 20 %)
050	voltage rating at 105 °C (050 = 50 V)
DG	can size (see dimensions table)
2	sleeve and sealing (2 = polyester sleeve)
D	packaging (D = bulk; straight leads)

STANDARD RATINGS in inches [millimeters]							
CAPACITANCE (µF)	**PART NUMBER***	**NOMINAL CASE SIZE D x L**	**Max. ESR AT + 25 °C (mΩ)**		**Max. RIPPLE AT + 105 °C (A)**		**Max. Z AT + 25 °C (mΩ) 100 Hz**
			120 Hz	**20 kHz - 40 kHz**	**120 Hz**	**20 kHz - 40 kHz**	
6.3 WVDC AT 125 °C, SURGE = 8 V							
330.0	510DX337M6R3CC2D	0.394 x 0.512 [10.0 x 13.0]	1206.0	507.0	0.294	0.454	457.0
1000.0	510DX108M6R3DG2D	0.492 x 0.787 [12.5 x 20.0]	398.0	201.0	0.697	0.984	181.0
1500.0	510DX158M6R3DK2D	0.492 x 0.984 [12.5 x 25.0]	265.0	133.0	0.931	1.313	121.0
4700.0	510DX478M6R3ER2D	0.630 x 1.417 [16.0 x 36.0]	85.0	40.0	2.193	3.193	36.0
10 WVDC AT 125 °C, SURGE = 13 V							
150.0	510DX157M010BB2D	0.315 x 0.472 [8.0 x 12.0]	2210.0	948.0	0.182	0.278	854.0
220.0	510DX227M010BD2D	0.315 x 0.630 [8.0 x 16.0]	1507.0	528.0	0.247	0.417	475.0
1200.0	510DX128M010DK2D	0.492 x 0.984 [12.5 x 25.0]	276.0	138.0	0.911	1.287	124.0
4700.0	510DX478M010FR2D	0.709 x 1.417[18.0 x 36.0]	71.0	37.0	2.582	3.576	33.0
16 WVDC AT 125 °C, SURGE = 20 V							
150.0	510DX157M016BD2D	0.315 x 0.630 [8.0 x 16.0]	1415.0	549.0	0.255	0.409	494.0
470.0	510DX477M016DG2D	0.492 x 0.787 [12.5 x 20.0]	451.0	216.0	0.654	0.946	194.0
2200.0	510DX228M016ER2D	0.630 x 1.417 [16.0 x 36.0]	96.0	43.0	2.060	3.078	39.0

Note
Call your nearest Vishay Sprague® distributor for price and delivery.

STANDARD RATINGS in inches [millimeters]							
CAPACITANCE (µF)	**PART NUMBER***	**NOMINAL CASE SIZE D x L**	**Max. ESR AT + 25 °C (mΩ)**		**Max. RIPPLE AT + 105 °C (A)**		**Max. Z AT + 25 °C (mΩ) 100 Hz**
			120 Hz	**20 kHz - 40 kHz**	**120 Hz**	**20 kHz - 40 kHz**	
25 WVDC AT 125 °C, SURGE = 32 V							
100.0	510DX107M025BD2D	0.315 x 0.630 [8.0 x 16.0]	1459.0	571.0	0.251	0.401	514.0
100.0	510DX107M025CC2D	0.394 x 0.512 [10.0 x 13.0]	1459.0	571.0	0.268	0.428	514.0
330.0	510DX337M025DG2D	0.492 x 0.787 [12.5 x 20.0]	442.0	224.0	0.661	0.927	202.0
470.0	510DX477M025DK2D	0.492 x 0.984 [12.5 x 25.0]	310.0	150.0	0.859	1.238	135.0
1500.0	510DX158M025ER2D	0.630 x 1.417 [16.0 x 36.0]	97.0	45.0	2.049	3.009	40.0
35 WVDC AT 125 °C, SURGE = 44 V							
47.0	510DX476M035BB2D	0.315 x 0.472 [8.0 x 12.0]	2822.0	1067.0	0.161	0.262	960.0
100.0	510DX107M035CC2D	0.394 x 0.512 [10.0 x 13.0]	1326.0	593.0	0.281	0.421	534.0
220.0	510DX227M035CG2D	0.394 x 0.787 [10.0 x 20.0]	603.0	248.0	0.496	0.774	223.0
470.0	510DX477M035DK2D	0.492 x 0.984 [12.5 x 25.0]	282.0	156.0	0.901	1.214	140.0
1200.0	510DX128M035EN2D	0.630 x 1.260 [16.0 x 32.0]	111.0	58.0	1.826	2.527	52.0
1500.0	510DX158M035ER2D	0.630 x 1.417 [16.0 x 36.0]	88.0	47.0	2.151	2.944	42.0
50 WVDC AT 125 °C, SURGE = 63 V							
220.0	510DX227M050DG2D	0.492 x 0.787 [12.5 x 20.0]	543.0	243.0	0.597	0.892	218.0
330.0	510DX337M050DK2D	0.492 x 0.984 [12.5 x 25.0]	362.0	162.0	0.796	1.191	146.0
1000.0	510DX108M050ER2D	0.630 x 1.417 [16.0 x 36.0]	119.0	49.0	1.847	2.883	44.0
63 WVDC AT 125 °C, SURGE = 79 V							
47.0	510DX476M063BD2D	0.315 x 0.630 [8.0 x 16.0]	1975.0	642.0	0.215	0.378	578.0
47.0	510DX476M063CC2D	0.394 x 0.512 [10.0 x 13.0]	1975.0	642.0	0.231	0.404	578.0
220.0	510DX227M063DK2D	0.492 x 0.984 [12.5 x 25.0]	422.0	168.0	0.737	1.167	151.0
1000.0	510DX108M063FR2D	0.709 x 1.417 [18.0 x 36.0]	93.0	45.0	2.256	3.243	41.0

Note

Call your nearest Vishay Sprague® distributor for price and delivery.

Aluminum Capacitors
+ 85 °C, Miniature, Axial Lead

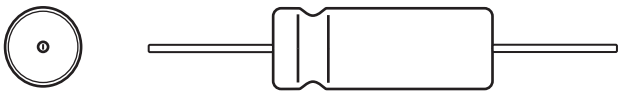


Fig.1 Component outlines

FEATURES

- Low leakage current
- Long shelf life
- Ideal for application in TV sets, auto radios, radio-phone combinations, electronic testing equipment

Pb-free Available

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	6.350 x 12.700 to 34.925 x 92.075
Operating temperature	
6 WVDC to 100 WVDC	- 40 °C to + 85 °C
101 WVDC to 475 WVDC	- 20 °C to + 85 °C
500 WVDC and higher	20 °C to + 65 °C
Rated Capacitance range, C_R	1 µF to 15 000 µF

ORDERING EXAMPLE [1]

Order by Distribution part no. Example: TVA1318.7

Note

[1] For lead (Pb)-free/RoHS compliant products add the suffix "-E3" to the part no. Example: TVA1318.7-E3

DIMENSIONS in inches [millimeters]					
CASE CODE	**D**	**L**	**CASE CODE**	**D**	**L**
BA	0.250 [6.350]	0.500 [12.700]	FJ	0.625 [15.875]	1.625 [41.275]
BB	0.250 [6.350]	0.687 [17.450]	FK	0.485 [12.319]	1.750 [44.450]
CB	0.312 [7.925]	0.687 [17.450]	GE	0.750 [19.050]	1.125 [28.575]
CC	0.312 [7.925]	0.812 [20.625]	GG	0.750 [19.050]	1.375 [34.925]
DC	0.375 [9.525]	0.812 [20.625]	GH	0.625 [15.875]	1.500 [38.100]
DD	0.375 [9.525]	0.937 [23.800]	GL	0.750 [19.050]	2.125 [53.975]
DF	0.375 [9.525]	1.250 [31.750]	GK	0.625 [15.875]	1.750 [44.450]
DH	0.375 [9.525]	1.500 [38.100]	GJ	0.750 [19.050]	1.625 [41.275]
EE	0.500 [12.700]	1.125 [28.575]	HG	0.875 [22.225]	1.375 [34.925]
EF	0.438 [11.125]	1.250 [31.750]	HJ	0.875 [22.225]	1.625 [41.275]
EG	0.500 [12.700]	1.375 [34.925]	HK	0.875 [22.225]	1.875 [47.625]
EH	0.438 [11.125]	1.500 [38.100]	HL	0.875 [22.225]	2.125 [53.975]
EJ	0.500 [12.700]	1.625 [41.275]	JB	1.0 [25.4]	3.375 [85.725]
FG	0.625 [15.875]	1.375 [34.925]	JJ	1.0 [25.4]	1.625 [41.275]
FH	0.485 [12.319]	1.500 [38.100]	JK	1.0 [25.4]	1.875 [47.625]
JL	1.0 [25.4]	2.125 [53.975]	KP	1.125 [28.575]	2.625 [66.675]
JN	1.0 [25.4]	2.375 [60.325]	KS	1.125 [28.575]	3.125 [79.375]
JP	1.0 [25.4]	2.625 [66.675]	LP	1.250 [31.750]	2.625 [66.675]
JR	1.0 [25.4]	2.875 [73.025]	LS	1.250 [31.750]	3.125 [79.375]
JS	1.0 [25.4]	3.125 [79.375]	LT	1.250 [31.750]	3.625 [92.075]
JU	1.0 [25.4]	3.625 [92.075]	MD	1.375 [34.925]	4.125 [104.775]
JW	1.0 [25.4]	3.875 [98.425]	MN	1.375 [34.925]	2.375 [60.325]
KL	1.125 [28.575]	2.125 [53.975]	MS	1.375 [34.925]	3.125 [79.375]
KN	1.125 [28.575]	2.375 [60.325]	MT	1.375 [34.925]	3.625 [92.075]

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	WVDC	CASE CODE	PART NUMBER (1)
SINGLE UNITS (POLARIZED)			
200.0	6	CB	TVA1101.7
5000.0	10	GK	TVA1129.5
25.0	16	BA	TVA1148
50.0	16	BB	TVA1150
100.0	16	CB	TVA1160
200.0	16	CC	TVA1160.6
250.0	16	DC	TVA1161
500.0	16	DD	TVA1162
600.0	16	DF	TVA1162.2
800.0	16	DF	TVA1162.3
1000.0	16	DH	TVA1163
1200.0	16	EH	TVA1164
1500.0	16	EH	TVA1175.2
2000.0	16	FK	TVA1170
3000.0	16	GH	TVA1175
5000.0	16	JL	TVA1175.5
10 000.0	16	LP	TVA1175.8
10.0	25	BA	TVA1204
25.0	25	BA	TVA1205
50.0	25	BB	TVA1206
75.0	25	CB	TVA1206.1
100.0	25	CC	TVA1207
150.0	25	DC	TVA1207.5
200.0	25	DC	TVA1207.7
250.0	25	DD	TVA1208
500.0	25	EF	TVA1209
1000.0	25	FH	TVA1211
1500.0	25	GH	TVA1212
2000.0	25	GK	TVA1213
2500.0	25	JK	TVA1213.5
5000.0	25	KP	TVA1214.5
500.0	35	EH	TVA1227
5500.0	35	JB	TVA1229
1.0	50	BA	TVA1300
2.0	50	BA	TVA1301
5.0	50	BA	TVA1303
5.0	50	BA	TVA1303.1
10.0	50	BA	TVA1304
15.0	50	BB	TVA1305
20.0	50	BB	TVA1305.5
25.0	50	BB	TVA1306
40.0	50	CC	TVA1306.5
50.0	50	CC	TVA1308
75.0	50	DC	TVA1309.4
100.0	50	DC	TVA1310
150.0	50	DD	TVA1311
200.0	50	DF	TVA1311.5
250.0	50	DH	TVA1312
300.0	50	EF	TVA1312.1
400.0	50	FH	TVA1313
500.0	50	FH	TVA1315
600.0	50	GH	TVA1315.2
1000.0	50	GK	TVA1316
1500.0	50	HL	TVA1318
2000.0	50	KL	TVA1318.2
2500.0	50	KP	TVA1318.3
3000.0	50	LP	TVA1318.4
5000.0	50	MS	TVA1318.7
1.0	63	BA	TVA1319.10
10.0	100	CB	TVA1337

Note

(1) For other capacitance and voltage ratings, please see Types 500D and 53D.

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	WVDC	CASE CODE	PART NUMBER (1)
SINGLE UNITS (POLARIZED)			
50.0	100	DF	TVA1343
100.0	100	EH	TVA1346
250.0	100	GK	TVA1349
500.0	100	KL	TVA1376
1.0	150	BA	TVA1400
2.0	150	BB	TVA1400.1
4.0	150	CC	TVA1402
5.0	150	CC	TVA1403
8.0	150	DC	TVA1405
10.0	150	DC	TVA1406
16.0	150	DD	TVA1409
20.0	150	DF	TVA1410
25.0	150	DF	TVA1411
30.0	150	EF	TVA1412
40.0	150	EH	TVA1413
50.0	150	EH	TVA1414
80.0	150	GK	TVA1418
100.0	150	GK	TVA1420
150.0	150	HL	TVA1422
200.0	150	JL	TVA1423
300.0	150	KP	TVA1425
3.0	200	CC	TVA1436
5.0	200	DC	TVA1438
10.0	200	DD	TVA1441
20.0	200	EF	TVA1442.1
100.0	200	HL	TVA1445
4.0	250	DC	TVA1501
10.0	250	DF	TVA1504
12.0	250	EF	TVA1505
20.0	250	EH	TVA1508
30.0	250	GH	TVA1510
40.0	250	GK	TVA1511
50.0	250	HG	TVA1512
60.0	250	HJ	TVA1513
100.0	250	JK	TVA1522
1.0	300	CB	TVA1540
3.0	350	DD	TVA1600.1
4.0	350	DF	TVA1601
5.0	350	DF	TVA1602.5
8.0	350	EH	TVA1603
10.0	350	EH	TVA1604
15.0	350	FK	TVA1607
20.0	350	GK	TVA1608
60.0	350	HL	TVA1613
100.0	350	JP	TVA1620
1.0	450	DC	TVA1700
2.0	450	DF	TVA1701
4.0	450	EH	TVA1702
5.0	450	EH	TVA1703
8.0	450	FK	TVA1704
10.0	450	GK	TVA1705
12.0	450	GK	TVA1706
20.0	450	HJ	TVA1709
30.0	450	HK	TVA1711
40.0	450	HL	TVA1712
50.0	450	KL	TVA1713
100.0	450	LS	TVA1718
60.0	450	KL	TVA1714
80.0	450	JP	TVA1716
20.0	500	HL	TVA1906
16.0	475	HJ	TVA1803.1
40.0	500	JN	TVA1908
10.0	600	JR	TVA1963
20.0	600	JW	TVA1966
30.0	500	JJ	TVA1907

Note

(1) For other capacitance and voltage ratings, please see Types 500D and 53D.

ELECTRICAL DATA AND ORDERING INFORMATION			
CAPACITANCE (µF)	WVDC	CASE CODE	PART NUMBER (1)
NON-POLARIZED			
50.0	10	CB	TVAN1117
10.0	25	BB	TVAN1204.1
16.0	25	BB	TVAN1204.3
25.0	25	CB	TVAN1205.1
50.0	25	CC	TVAN1206.1
100.0	25	DD	TVAN1207.1
20.0	30	CB	TVAN1220
2.0	50	BA	TVAN1301.1
3.0	50	BA	TVAN1302.1
5.0	50	BB	TVAN1303.1
8.0	50	BB	TVAN1303.4
10.0	50	CB	TVAN1304.1
25.0	50	DC	TVAN1306.1
50.0	50	DD	TVAN1308.1
100.0	50	DH	TVAN1310.1
10.0	100	EJ	TVAN1333
20.0	100	FJ	TVAN1335
60.0	200	JP	TVAN1440
1.0	300	EG	TVAN1560
5.0	350	GJ	TVAN1602
20.0	400	JL	TVAN1652

Note

(1) For other capacitance and voltage ratings, please see Types 500D and 53D.

Aluminum Capacitors
+ 85 °C, Powerlytic® Electrolytics

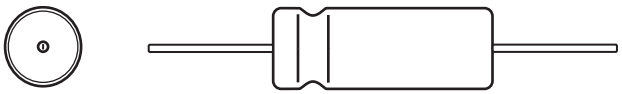


Fig.1 Component outlines

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Operating temperature	- 20 °C to + 85 °C
Tolerance on C_R: 3 WVDC to 75 WVDC 100 WVDC to 450 WVDC	 + 75 %, - 10 % + 50 %, - 10 %
Dissipation Factor: 3 WVDC and 6 WVDC 10 WVDC and 15 WVDC 25 WVDC and 30 WVDC 40 WVDC and 50 WVDC 75 WVDC and 100 WVDC 150 WVDC to 450 WVDC	 230 % 150 % 60 % 45 % 30 % 18 %
Ripple current	20 to 3140 maximum amperes rms at 120 Hz and + 120 °C, depending upon capacitance
Useful life at 85 °C	500 hours

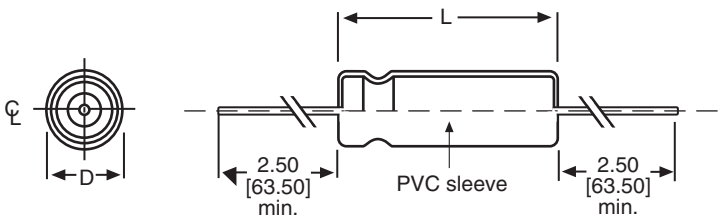
FEATURES

- Designed for applications requiring greatest possible capacitance in small physical case sizes
- Supplement original Type 36D can-type capacitors, offering lower capacitance values in smaller sizes with axial leads
- Welds at all critical anode and cathode terminals eliminate riveted or pressure connections to assure freedom from open circuits even when operated in the microvolt or millivolt signal range
- Improved molded phenolic and seals
- Pressure-sensitive safety vent
- Service life of 10 years or more in normal circuit applications
- Capacitors listed have outer plastic-film insulation. For bare case, change last character of part number from 6 to 0 and subtract 0.062" [1.575 mm] from diameter and 0.125" [3.175 mm] from length

DIMENSIONS in inches [millimeters]

CASE CODE	D	L	CASE CODE	D	L	CASE CODE	D	L
	± 0.020 [0.51]	± 0.062 [1.58]		± 0.020 [0.51]	± 0.062 [1.58]		± 0.020 [0.51]	± 0.062 [1.58]
EE	0.510 [13.0]	1.141 [29.0]	GJ	0.760 [19.3]	1.641 [41.7]	JE	1.010 [25.7]	1.141 [29.0]
EJ	0.510 [13.0]	1.641 [41.7]	GL	0.760 [19.3]	2.141 [54.4]	JJ	1.010 [25.7]	1.641 [41.7]
EL	0.510 [13.0]	2.141 [54.4]	GP	0.760 [19.3]	2.641 [67.1]	JL	1.010 [25.7]	2.141 [54.4]
FE	0.635 [16.1]	1.141 [29.0]	HE	0.885 [22.5]	1.141 [29.0]	JP	1.010 [25.7]	2.641 [67.1]
FJ	0.635 [16.1]	1.641 [41.7]	HJ	0.885 [22.5]	1.641 [41.7]	JS	1.010 [25.7]	3.141 [79.8]
FL	0.635 [16.1]	2.141 [54.4]	HL	0.885 [22.5]	2.141 [54.4]	JT	1.010 [25.7]	3.641 [92.5]
FP	0.635 [16.1]	2.641 [67.1]	HP	0.885 [22.5]	2.641 [67.1]	-	-	-
GE	0.760 [19.3]	1.141 [29.0]	HS	0.885 [22.5]	3.141 [79.8]	-	-	-

DIMENSIONS AND AVAILABLE FORMS



Tinned copper leads

$\frac{0.040}{1.016}$ Dia. (No. 18 AWG)

Aluminum Capacitors
+ 85 °C, Powerlytic® Electrolytics

ORDERING EXAMPLE

Electrolytic capacitor 39D series: 39D 907 G 003 EJ 6

DESCRIPTION	
CODE	**EXPLANATION**
39D	product type
907	capacitance value (900 µF)
G	tolerance (G = - 10 %/+ 75 %; F = - 10 %/+ 50 %)
003	voltage rating at 85 °C (003 = 3 V)
EJ	can size (see dimensions table)
6	sleeve and sealing (6 = P.V.C. sleeve)

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	CASE CODE	PART NUMBER
3 WVDC at + 85 °C, SURGE = 4 V		
400	EE	39D407G003EE6
900	EJ	39D907G003EJ6
1300	EL	39D138G003EL6
1400	GE	39D148G003GE6
1800	FJ	39D188G003FJ6
2100	HE	39D218G003HE6
2700	FL	39D278G003FL6
2900	GJ	39D298G003GJ6
3000	JE	39D308G003JE6
3600	FP	39D368G003FP6
4200	HJ	39D428G003HJ6
4300	GL	39D438G003GL6
5700	GP	39D578G003GP6
6000	JJ	39D608G003JJ6
8500	HP	39D858G003HP6
9000	JL	39D908G003JL6
10 000	HS	39D109G003HS6
12 000	JP	39D129G003JP6
15 000	JS	39D159G003JS6
18 000	JT	39D189G003JT6
6 WVDC at + 85 °C, SURGE = 8 V		
300	EE	39D307G006EE6
600	EJ	39D607G006EJ6
900	EL	39D907G006EL6
1000	GE	39D108G006GE6
1200	FJ	39D128G006FJ6
1500	HE	39D158G006HE6
1900	FL	39D198G006FL6
2000	GJ	39D208G006GJ6
2100	JE	39D218G006JE6
2500	FP	39D258G006FP6
3000	GL	39D308G006GL6
4000	GP	39D408G006GP6
4200	JJ	39D428G006JJ6
6000	HP	39D608G006HP6
6300	JL	39D638G006JL6
7500	HS	39D758G006HS6
8500	JP	39D858G006JP6
10 000	JS	39D109G006JS6
12 000	JT	39D129G006JT6

Notes

(1) These values are normally stocked. Case codes subject to change without notice.
'4' suffix was clear PVC sleeve. '6' is blue

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	CASE CODE	PART NUMBER
10 WVDC at + 85 °C, SURGE = 12 V		
250	EE	39D257G010EE6
500	EJ	39D507G010EJ6
800	EL	39D807G010EL6
850	GE	39D857G010GE6
1000.0 (1)	FJ	39D108G010FJ6
1200	HE	39D128G010HE6
1600	FL	39D168G010FL6
1700	GJ	39D178G010GJ6
2100	FP	39D218G010FP6
2500	GL	39D258G010GL6
3400	GP	39D348G010GP6
3500	JJ	39D358G010JJ6
5000	HP	39D508G010HP6
5200	JL	39D528G010JL6
6300	HS	39D638G010HS6
7100	JP	39D718G010JP6
8800	JS	39D888G010JS6
10 000	JT	39D109G010JT6
15 WVDC at + 85 °C, SURGE = 18 V		
200	EE	39D207G015EE6
400	EJ	39D407G015EJ6
600	EL	39D607G015EL6
800	FJ	39D807G015FJ6
950	HE	39D957G015HE6
1200.0 (1)	FL	39D128G015FL6
1300	GJ	39D138G015GJ6
1600	FP	39D168G015FP6
1900	GL	39D198G015GL6
2500	GP	39D258G015GP6
2600	JJ	39D268G015JJ6
3800	HP	39D388G015HP6
4000	JL	39D408G015JL6
4700	HS	39D478G015HS6
5300	JP	39D538G015JP6
6600	JS	39D668G015JS6
8000.0 (1)	JT	39D808G015JT6
25 WVDC at + 85 °C, SURGE = 30 V		
100	EE	39D107G025EE6
200	EJ	39D207G025EJ6
350	EL	39D357G025EL6
450	FJ	39D457G025FJ6
500.0 (1)	HE	39D507G025HE6
700	FL	39D707G025FL6
750	GJ	39D757G025GJ6
800	JE	39D807G025JE6
950	FP	39D957G025FP6
1000.0 (1)	GL	39D108G025GL6
1100	HJ	39D118G025HJ6
1500	GP	39D158G025GP6
1600	JJ	39D168G025JJ6
1700	HL	39D178G025HL6
2200.0 (1)	HP	39D228G025HP6
2400	JL	39D248G025JL6
2800	HS	39D288G025HS6
3200	JP	39D328G025JP6
4000.0 (1)	JS	39D408G025JS6
4700.0 (1)	JT	39D478G025JT6

Notes

(1) These values are normally stocked. Case codes subject to change without notice.
'4' suffix was clear PVC sleeve. '6' is blue

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	CASE CODE	PART NUMBER
30 WVDC at + 85 °C, SURGE = 40 V		
75	EE	39D756G030EE6
150	EJ	39D157G030EJ6
250	EL	39D257G030EL6
350	FJ	39D357G030FJ6
400	HE	39D407G030HE6
500.0 (1)	FL	39D507G030FL6
600.0 (1)	JE	39D607G030JE6
700	FP	39D707G030FP6
850	GL	39D857G030GL6
1100.0 (1)	GP	39D118G030GP6
1200	HL	39D128G030HL6
1700	HP	39D178G030HP6
1800	JL	39D188G030JL6
2100	HS	39D218G030HS6
2400	JP	39D248G030JP6
3000.0 (1)	JS	39D308G030JS6
3600	JT	39D368G030JT6
40 WVDC at + 85 °C, SURGE = 50 V		
75	EE	39D756G040EE6
150	EJ	39D157G040EJ6
200	EL	39D207G040EL6
250	GE	39D257G040GE6
300	FJ	39D307G040FJ6
350	HE	39D357G040HE6
450	FL	39D457G040FL6
500.0 (1)	GJ	39D507G040GJ6
600	FP	39D607G040FP6
750	GL	39D757G040GL6
1000.0 (1)	GP	39D108G040GP6
1100	HL	39D118G040HL6
1500	HP	39D158G040HP6
1600	JL	39D168G040JL6
1900	HS	39D198G040HS6
2100	JP	39D218G040JP6
2600	JS	39D268G040JS6
3200	JT	39D328G040JT6
50 WVDC at + 85 °C, SURGE = 65 V		
50	EE	39D506G050EE6
100	EJ	39D107G050EJ6
150	EL	39D157G050EL6
200.0 (1)	FJ	39D207G050FJ6
250.0 (1)	HE	39D257G050HE6
350	FL	39D357G050FL6
450	FP	39D457G050FP6
500.0 (1)	GL	39D507G050GL6
700	GP	39D707G050GP6
750	JJ	39D757G050JJ6
800.0 (1)	HL	39D807G050HL6
1100.0 (1)	HP	39D118G050HP6
1300	HS	39D138G050HS6
1500	JP	39D158G050JP6
1900	JS	39D198G050JS6
2300.0 (1)	JT	39D238G050JT6

Notes

(1) These values are normally stocked. Case codes subject to change without notice.
'4' suffix was clear PVC sleeve. '6' is blue

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	CASE CODE	PART NUMBER
75 WVDC at + 85 °C, SURGE = 95 V		
30	EE	39D306G075EE6
75	EJ	39D756G075EJ6
100	EL	39D107G075EL6
150.0 (1)	FJ	39D157G075FJ6
200	FL	39D207G075FL6
250.0 (1)	JE	39D257G075JE6
300	FP	39D307G075FP6
350	GL	39D357G075GL6
450	GP	39D457G075GP6
500	HL	39D507G075HL6
700	HP	39D707G075HP6
750	JL	39D757G075JL6
850	HS	39D857G075HS6
1000.0 (1)	JP	39D108G075JP6
1200	JS	39D128G075JS6
1500	JT	39D158G075JT6
100 WVDC at + 85 °C, SURGE = 125 V		
15	EE	39D156F100EE6
35	EJ	39D356F100EJ6
55	EL	39D556F100EL6
60	GE	39D606F100GE6
75	FJ	39D756F100FJ6
90	HE	39D906F100HE6
110	FL	39D117F100FL6
120	GJ	39D127F100GJ6
130	JE	39D137F100JE6
150	FP	39D157F100FP6
180	HJ	39D187F100HJ6
190	GL	39D197F100GL6
250	GP	39D257F100GP6
260	JJ	39D267F100JJ6
280	HL	39D287F100HL6
370	HP	39D377F100HP6
390	JL	39D397F100JL6
460	HS	39D467F100HS6
520	JP	39D527F100JP6
650	JS	39D657F100JS6
780	JT	39D787F100JT6
150 WVDC at + 85 °C, SURGE = 175 V		
10	EE	39D106F150EE6
25	EJ	39D256F150EJ6
40	EL	39D406F150EL6
50	FJ	39D506F150FJ6
60	HE	39D606F150HE6
80	FL	39D806F150FL6
85	GJ	39D856F150GJ6
88	JE	39D886F150JE6
100	FP	39D107F150FP6
120	GL	39D127F150GL6
170	GP	39D177F150GP6
190	HL	39D197F150HL6
250	HP	39D257F150HP6
260	JL	39D267F150JL6
310	HS	39D317F150HS6
350	JP	39D357F150JP6
440	JS	39D447F150JS6
530	JT	39D537F150JT4

Notes

(1) These values are normally stocked. Case codes subject to change without notice.
'4' suffix was clear PVC sleeve. '6' is blue

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	CASE CODE	PART NUMBER
200 WVDC at + 85 °C, SURGE = 250 V		
9	EE	39D905F200EE6
15	EJ	39D156F200EJ6
25	EL	39D256F200EL6
30	GE	39D306F200GE6
35	FJ	39D356F200FJ6
40	HE	39D406F200HE6
55	FL	39D556F200FL6
60	GJ	39D606F200GJ6
75	FP	39D756F200FP6
80	HJ	39D806F200HJ6
90	GL	39D906F200GL6
120	GP	39D127F200GP6
130	HL	39D137F200HL6
170	HP	39D177F200HP6
180	JL	39D187F200JL6
220	HS	39D227F200HS6
250	JP	39D257F200JP6
310	JS	39D317F200JS6
370	JT	39D377F200JT6
250 WVDC at + 85 °C, SURGE = 300 V		
7	EE	39D705F250EE6
15	EJ	39D156F250EJ6
20	EL	39D206F250EL6
30	FJ	39D306F250FJ6
35	HE	39D356F250HE6
45	FL	39D456F250FL6
50.0 (1)	JE	39D506F250JE6
60	FP	39D606F250FP6
70	GL	39D706F250GL6
95	GP	39D956F250GP6
100.0 (1)	HL	39D107F250HL6
140	HP	39D147F250HP6
150.0 (1)	JL	39D157F250JL6
180	HS	39D187F250HS6
200.0 (1)	JP	39D207F250JP6
250	JS	39D257F250JS6
300.0 (1)	JT	39D307F250JT6
300 WVDC at + 85 °C, SURGE = 350 V		
5	EE	39D505F300EE6
10	EJ	39D106F300EJ6
15	EL	39D156F300EL6
20	FJ	39D206F300FJ6
25	HE	39D256F300HE6
30	FL	39D306F300FL6
40	FP	39D406F300FP6
50	GL	39D506F300GL6
65	GP	39D656F300GP6
75	HL	39D756F300HL6
300 WVDC at + 85 °C, SURGE = 350 V		
100	HP	39D107F300HP6
120	HS	39D127F300HS6
130	JP	39D137F300JP6
170	JS	39D177F300JS6
200	JT	39D207F300JT6

Notes

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'4' suffix was clear PVC sleeve. '6' is blue

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	CASE CODE	PART NUMBER
350 WVDC at + 85 °C, SURGE = 400 V		
4	EE	39D405F350EE6
8	EJ	39D805F350EJ6
12	EL	39D126F350EL6
15	FJ	39D156F350FJ6
20	FL	39D206F350FL6
25	GJ	39D256F350GJ6
30	FP	39D306F350FP6
40	GL	39D406F350GL6
50	GP	39D506F350GP6
60	HL	39D606F350HL6
80	HP	39D806F350HP6
100	HS	39D107F350HS6
110	JP	39D117F350JP6
130	JS	39D137F350JS6
160	JT	39D167F350JT6
400 WVDC at + 85 °C, SURGE = 475 V		
2	EE	39D205F400EE6
5	EJ	39D505F400EJ6
10	FJ	39D106F400FJ6
15	F	39D156F400FL6
20	F	39D206F400FP6
25	GL	39D256F400GL6
35	GP	39D356F400GP6
40	HL	39D406F400HL6
55	HP	39D556F400HP6
65	HS	39D656F400HS6
75	JP	39D756F400JP6
90	JS	39D906F400JS6
110	JT	39D117F400JT6
450 WVDC at + 85 °C, SURGE = 525 V		
1	EE	39D105F450EE6
3	EJ	39D305F450EJ6
5	EL	39D505F450EL6
10	FL	39D106F450FL6
15	FP	39D156F450FP6
20	GL	39D206F450GL6
25	GP	39D256F450GP6
35	HP	39D356F450HP6
45	HS	39D456F450HS6
50	JP	39D506F450JP6
65	JS	39D656F450JS6
75	JT	39D756F450JT6

Notes

(1) These values are normally stocked. Case codes subject to change without notice.

- '4' suffix was clear PVC sleeve. '6' is blue

Aluminum Capacitors
+ 85 °C, Tubular, Axial Lead, General Purpose

Fig.1 Component outlines

FEATURES

- General purpose capacitor
- Rugged construction
- Largest CV ratings in axial leaded capacitor

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.75" x 1.125" [19.05 x 28.575] to 1.375"x 4.125" [34.925 x 104.775]
Operating temperature	- 40 °C to + 85 °C
Rated capacitance range, C_R	15 µF to 220 000 µF
Tolerance on C_R	- 10 %, + 50 %; - 10 %, + 75 %
Rated voltage range, U_R	6.3 WVDC to 450 WVDC
Termination	Axial leads
Life validation test at 85 °C	1000 hours: Δ CAP ≤ 15 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ initial specified limit
Shelf life at 85 °C	500 hours: Δ CAP ≤ 10 % from initial measurement. Δ ESR ≤ 1.3 x initial specified limit. Δ DCL ≤ 2.0 x initial specified limit.
DC leakage current	$I = K \sqrt{CV}$ K = 6.0 at + 25 °C; 36.0 at + 85 °C I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE			
Ambient Temperature		Multipliers	
+ 75 °C		1.4	
+ 65 °C		1.7	
+ 45 °C and below		2.0	
FREQUENCY (Hz)			
WVDC	50 - 60	300 - 400	1000 AND UP
0 - 50	0.85	1.10	1.15
51 - 299	0.85	1.15	1.20
300 - up	0.80	1.30	1.40

LOW TEMPERATURE PERFORMANCE

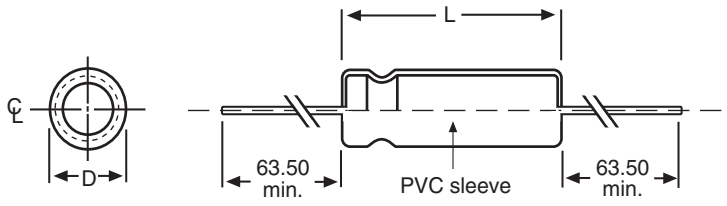
CAPACITANCE RATIO $C_{-40\,°C}/C_{+25\,°C}$ MINIMUM at 120 Hz	
Rated Voltage (WVDC)	Capacitance Remaining
0 - 40	35
41 - 63	45
64 - 100	60
101 - 350	20
351 - 450	15
ESR RATIO $ESR_{-40\,°C}/ESR_{+25\,°C}$ MAXIMUM at 120 Hz	
Rated Voltage (WVDC)	Multiplier
0 - 40	60
41 - 63	55
64 - 100	65
101 - 350	180
351 - 450	190

DIMENSIONS in inches [millimeters]

CASE CODE	STYLE 6 AND 7		TYPICAL WEIGHT	CASE CODE	STYLE 6 AND 7		TYPICAL WEIGHT
	D	L			D	L	
GE	0.760 ± 0.020 [19.3 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.58]	0.46 oz. (13 g)	GL	0.760 ± 0.020 [19.3 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.58]	0.74 oz. (21 g)
GJ	0.760 ± 0.020 [19.3 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.58]	0.67 oz. (19 g)	GP	0.760 ± 0.020 [19.3 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.58]	0.88 oz. (25 g)
GS	0.760 ± 0.020 [19.3 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.58]	1.16 oz. (33 g)	KS	1.135 ± 0.020 [28.8 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.58]	2.54 oz. (72 g)
GT	0.760 ± 0.020 [19.3 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.58]	1.34 oz. (38 g)	KT	1.135 ± 0.020 [28.8 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.58]	2.96 oz. (84 g)
HE	0.885 ± 0.020 [22.5 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.58]	0.63 oz. (18 g)	KD	1.135 ± 0.020 [28.8 ± 0.51]	4.141 ± 0.062 [105.2 ± 1.58]	3.35 oz. (95 g)

DIMENSIONS in inches [millimeters]							
CASE CODE	**STYLE 6 AND 7**		**TYPICAL WEIGHT**	**CASE CODE**	**STYLE 6 AND 7**		**TYPICAL WEIGHT**
	D	**L**			**D**	**L**	
HJ	0.885 ± 0.020 [22.5 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.58]	0.95 oz. (27 g)	LE	1.260 ± 0.020 [32.0 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.58]	1.13 oz. (32 g)
HL	0.885 ± 0.020 [22.5 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.58]	1.02 oz. (29 g)	LJ	1.260 ± 0.020 [32.0 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.58]	1.62 oz. (46 g)
HP	0.885 ± 0.020 [22.5 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.58]	1.38 oz. (39 g)	LL	1.260 ± 0.020 [32.0 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.58]	2.11 oz. (60 g)
HS	0.885 ± 0.020 [22.5 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.58]	1.73 oz. (49 g)	LP	1.260 ± 0.020 [32.0 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.58]	2.65 oz. (75 g)
HT	0.885 ± 0.020 [22.5 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.58]	2.08 oz. (59 g)	LS	1.260 ± 0.020 [32.0 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.58]	3.14 oz. (89 g)
JE	1.010 ± 0.020 [25.7 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.58]	0.81 oz. (23 g)	LT	1.260 ± 0.020 [32.0 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.58]	3.63 oz. (103 g)
JJ	1.010 ± 0.020 [25.7 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.58]	1.02 oz. (29 g)	LD	1.260 ± 0.020 [32.0 ± 0.51	4.141 ± 0.062 [105.2 ± 1.58]	4.16 oz. (118 g)
JL	1.010 ± 0.020 [25.7 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.58]	1.55 oz. (44 g)	ME	1.375 ± 0.020 [34.9 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.58]	1.38 oz. (39 g)
JP	1.010 ± 0.020 [25.7 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.58]	1.87 oz. (53 g)	MJ	1.375 ± 0.020 [34.9 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.58]	1.98 oz. (56 g)
JS	1.010 ± 0.020 [25.7 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.58]	2.22 oz. (63 g)	ML	1.375 ± 0.020 [34.9 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.58]	2.57 oz. (73 g)
JT	1.010 ± 0.020 [25.7 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.58]	2.54 oz. (72 g)	MP	1.375 ± 0.020 [34.9 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.58]	3.21 oz. (91 g)
KE	1.135 ± 0.020 [28.8 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.58]	0.92 oz. (26 g)	MS	1.375 ± 0.020 [34.9 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.58]	3.81 oz. (108 g)
KJ	1.135 ± 0.020 [28.8 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.58]	1.31 oz. (37 g)	MT	1.375 ± 0.020 [34.9 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.58]	4.44 oz. (126 g)
KL	1.135 ± 0.020 [28.8 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.58]	1.73 oz. (49 g)	MD	1.375 ± 0.020 [34.9 ± 0.51]	4.141 ± 0.062 [105.2 ± 1.58]	5.04 oz. (143 g)
KP	1.135 ± 0.020 [28.8 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.58]	2.15 oz. (61 g)	-	-	-	-

DIMENSIONS AND AVAILABLE FORMS



ORDERING EXAMPLE

Electrolytic capacitor 53D series: 53D 282 G 025 GJ 6

DESCRIPTION	
CODE	**EXPLANATION**
53D	product type
282	capacitance value (2800 µF)
G	tolerance (G = - 10 %/+ 75 %; F = - 10 %/+ 50 %)
025	voltage rating at 85 °C (025 = 25 V)
GJ	can size (see dimensions table)
6	sleeve and sealing (6 = P.V.C. sleeve)

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	CASE CODE	PART NUMBER (1)	MAX. ESR at + 25 °C 120 Hz (mΩ)	MAX. RMS RIPPLE at + 85 °C 120 Hz (mA)
16 WVDC at + 85 °C, SURGE = 18 V				
6900.0	HJ	53D692G016HJ6	73	2150
10000.0	HL	53D103G016HL6	52	2840
25 WVDC at + 85 °C, SURGE = 35 V				
2800.0	GJ	53D282G025GJ6	103	1650
4300.0	HJ	53D432G025HJ6	72	2170
6200.0	HL	53D622G025HL6	51	2870
11000.0	JP	53D113G025JP6	33	4230
35 WVDC at + 85 °C, SURGE = 45 V				
1100.0	GE	53D112G035GE6	219	980
2100.0	GJ	53D212G035GJ6	111	1590
3200.0	HJ	53D322G035HJ6	77	2090
4700.0	HL	53D472G035HL6	54	2780
8300.0	JP	53D832G035JP6	34	4110
50 WVDC at + 85 °C, SURGE = 70 V				
1000.0	GE	53D102G050GE6	231	950
1300.0	GJ	53D132G050GJ6	131	1470
1900.0	HJ	53D192G050HJ6	94	1900
2800.0	HL	53D282G050HL6	65	2540
3800.0	JL	53D382G050JL6	51	3090
5000.0	JP	53D502G050JP6	40	3810
63 WVDC at + 85 °C, SURGE = 80 V				
1000.0	GJ	53D102G063GJ6	145	1400
2200.0	HL	53D222G063HL6	86	2210
200 WVDC at + 85 °C, SURGE = 250 V				
350.0	JL	53D351F200JL6	499	1000
460.0	JP	53D461F200JP6	379	1250
250 WVDC at + 85 °C, SURGE = 300 V				
56.0	GE	53D560F250GE6	3035	263
100.0	GJ	53D101F250GJ6	1593	420
130.0	HJ	53D131F250HJ6	1238	520
400 WVDC at + 85 °C, SURGE = 450 V				
100.0	JL	53D101F400JL6	1524	560
140.0	JS	53D141F400JS6	1084	790
150.0	JS	53D151F400JS6	1011	820

Note

(1) These Part Numbers are normally stocked. Many other values are available on special order. Please contact your distributor for price and delivery.

Aluminum Capacitors
+ 85 °C, Miniature, General Purpose

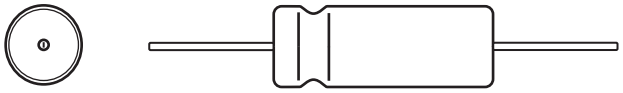


Fig.1 Component outline

FEATURES

- Increased CV efficiency
- New 0.709" [18.0 mm] diameter case size

Pb-free Available

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	0.248" x 0.512" [6.3 x 13.0] to 0.709" x 1.574" [18.0 x 40.0]
Operating temperature	- 40 °C to + 85 °C (3 WVDC to 250 WVDC) - 20 °C to + 85 °C (251 WVDC to 450 WVDC)
Rated capacitance range, C_R	0.22 µF to 10 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 450 WVDC
Life validation test at 85 °C	2000 hours: Δ CAP ≤ 20 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at 85 °C	500 hours: Δ CAP ≤ 20 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ 2.0 x initial specified limit.
DC leakage current	3 WVDC to 100 WVDC I = 0.01 CV + 10 101 WVDC to 450 WVDC I = 0.03 CV + 20 I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS				
TEMPERATURE				
Ambient Temperature			**Multipliers**	
+ 85 °C			1.0	
+ 75 °C			1.25	
≤ 65 °C			1.5	
FREQUENCY (Hz)				
WVDC	**50 - 60**	**100 - 120**	**300 - 400**	**1K - 100K**
0 - 50	0.85	1.0	1.05	1.1
51 - 450	0.80	1.0	1.30	1.5

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL		STYLE 2		STYLE 5	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)
BA	0.248 [6.300]	0.512 [13.000]	0.276 [7.000]	0.567 [14.400]	0.276 [7.000]	0.626 [15.900]
BB	0.248 [6.300]	0.689 [17.500]	0.276 [7.000]	0.756 [19.200]	0.276 [7.000]	0.815 [20.700]
CB	0.315 [8.000]	0.689 [17.500]	0.339 [8.600]	0.756 [19.200]	0.339 [8.600]	0.815 [20.700]
CC	0.315 [8.000]	0.807 [20.500]	0.339 [8.600]	0.878 [22.300]	0.339 [8.600]	0.937 [23.800]
DC	0.374 [9.500]	0.807 [20.500]	0.402 [10.200]	0.878 [22.300]	0.402 [10.200]	0.937 [23.800]
DD	0.374 [9.500]	0.945 [24.000]	0.402 [10.200]	1.01 [25.500]	0.402 [10.200]	1.063 [27.000]
DF	0.374 [9.500]	1.260 [32.000]	0.402 [10.200]	1.319 [33.500]	0.402 [10.200]	1.378 [35.000]
DH	0.374 [9.500]	1.496 [38.000]	0.402 [10.200]	1.567 [39.800]	0.402 [10.200]	1.626 [41.300]

DIMENSIONS in inches [millimeters]						
CASE CODE	**NOMINAL**		**STYLE 2**		**STYLE 5**	
	D	**L**	**D (max.)**	**L (max.)**	**D (max.)**	**L (max.)**
EF	0.433 [11.000]	1.260 [32.000]	0.465 [11.800]	1.319 [33.500]	0.465 [11.800]	1.378 [35.000]
EH	0.433 [11.000]	1.496 [38.000]	0.465 [11.800]	1.567 [39.800]	0.465 [11.800]	1.626 [41.300]
FH	0.492 [12.500]	1.496 [38.000]	0.516 [13.100]	1.567 [39.800]	0.516 [13.100]	1.626 [41.300]
FK	0.492 [12.500]	1.752 [44.500]	0.516 [13.100]	1.831 [46.500]	0.516 [13.100]	1.890 [48.000]
GH	0.630 [16.000]	1.496 [38.000]	0.654 [16.600]	1.567 [39.800]	0.654 [16.600]	1.626 [41.300]
GK	0.630 [16.000]	1.752 [44.500]	0.654 [16.600]	1.831 [46.500]	0.654 [16.600]	1.890 [48.000]
LS	0.709 [18.000]	1.575 [40.000]	0.736 [18.700]	1.673 [42.500]	0.736 [18.700]	1.693 [43.000]

ORDERING EXAMPLE

Electrolytic capacitor 500D series: 500D 686 M 6R3 BA 2 A

DESCRIPTION	
CODE	**EXPLANATION**
500D	product type
686	capacitance value (68 µF)
M	tolerance (M = ± 20 %)
6R3	voltage rating at 85 °C (6R3 = 6.3 V)
BA	can size (see dimensions table)
2	sleeve and sealing (2 = P.V.C. sleeve)
A	packaging (A = bulk)

ELECTRICAL DATA AND ORDERING INFORMATION		
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**
6.3 WVDC at + 85 °C, SURGE = 8 V		
68	500D686M6R3BA2A	0.248 x 0.512 [6.3 x 13.0]
150	500D157M6R3BB2A	0.248 x 0.689 [6.3 x 17.5]
220	500D227M6R3CB2A	0.315 x 0.689 [8.0 x 17.5]
330	500D337M6R3CC2A	0.315 x 0.807 [8.0 x 20.5]
680	500D687M6R3DC2A	0.374 x 0.807 [9.5 x 20.5]
820	500D827M6R3DD2A	0.374 x 0.945 [9.5 x 24.0]
1200	500D128M6R3DF2A	0.374 x 1.260 [9.5 x 32.0]
2200	500D228M6R3DH2A	0.374 x 1.496 [9.5 x 38.0]
2200	500D228M6R3EF2A	0.433 x 1.260 [11.0 x 32.0]
3300	500D338M6R3EH2A	0.433 x 1.496 [11.0 x 38.0]
3300	500D338M6R3FH2A	0.492 x 1.496 [12.5 x 38.0]
4700	500D478M6R3FK2A	0.492 x 1.752 [12.5 x 44.5]
5600	500D568M6R3GH2A	0.630 x 1.496 [16.0 x 38.0]
8200	500D828M6R3GK2A	0.630 x 1.752 [16.0 x 44.5]
10 000	500D109M6R3LS2A	0.709 x 1.575 [18.0 x 40.0]
10 WVDC at + 85 °C, SURGE = 12 V		
47	500D476M010BA2A	0.248 x 0.512 [6.3 x 13.0]
100	500D107M010BB2A	0.248 x 0.689 [6.3 x 17.5]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L
10 WVDC at + 85 °C, SURGE = 12 V		
220	500D227M010CB2A	0.315 x 0.689 [8.0 x 17.5]
330	500D337M010CC2A	0.315 x 0.807 [8.0 x 20.5]
470	500D477M010DC2A	0.374 x 0.807 [9.5 x 20.5]
680	500D687M010DD2A	0.374 x 0.945 [9.5 x 24.0]
1000	500D108M010DF2A	0.374 x 1.260 [9.5 x 32.0]
1500	500D158M010DH2A	0.374 x 1.496 [9.5 x 38.0]
1800	500D188M010EF2A	0.433 x 1.260 [11.0 x 32.0]
2200.0 (1)	500D228M010EH2	0.433 x 1.496 [11.0 x 38.0]
2700	500D278M010EH2A	0.433 x 1.496 [11.0 x 38.0]
2700	500D278M010FH2A	0.492 x 1.496 [12.5 x 38.0]
3300.0 (1)	500D338M010GH2	0.630 x 1.496 [16.0 x 38.0]
3900	500D398M010FK2A	0.492 x 1.752 [12.5 x 44.5]
4700	500D478M010GH2A	0.630 x 1.496 [16.0 x 38.0]
6800	500D688M010GK2A	0.630 x 1.752 [16.0 x 44.5]
8200	500D828M010LS2A	0.709 x 1.575 [18.0 x 40.0]
12 WVDC at + 85 °C, SURGE = 15 V		
39	500D396M012BA2A	0.248 x 0.512 [6.3 x 13.0]
68	500D686M012BB2A	0.248 x 0.689 [6.3 x 17.5]
150	500D157M012CB2A	0.315 x 0.689 [8.0 x 17.5]
220	500D227M012CC2A	0.315 x 0.807 [8.0 x 20.5]
330	500D337M012DC2A	0.374 x 0.807 [9.5 x 20.5]
560	500D567M012DD2A	0.374 x 0.807 [9.5 x 20.5]
820	500D827M012DF2A	0.374 x 1.260 [9.5 x 32.0]
1200	500D128M012DH2A	0.374 x 1.496 [9.5 x 38.0]
1500	500D158M012EF2A	0.433 x 1.260 [11.0 x 32.0]
2200	500D228M012EH2A	0.433 x 1.496 [11.0 x 38.0]
2200	500D228M012FH2A	0.492 x 1.496 [12.5 x 38.0]
2700	500D278M012FK2A	0.492 x 1.752 [12.5 x 44.5]
3900	500D398M012GH2A	0.630 x 1.496 [16.0 x 38.0]
5600	500D568M012GK2A	0.630 x 1.752 [16.0 x 44.5]
6800	500D688M012LS2A	0.709 x 1.575 [18.0 x 40.0]
16 WVDC at + 85 °C, SURGE = 20 V		
33	500D336M016BA2A	0.248 x 0.512 [6.3 x 13.0]
68	500D686M016BB2A	0.248 x 0.689 [6.3 x 17.5]
100.0 (1)	500D107M016CB2	0.315 x 0.689 [8.0 x 17.5]
150	500D157M016CB2A	0.315 x 0.689 [8.0 x 17.5]
220	500D227M016CC2A	0.315 x 0.807 [8.0 x 20.5
330	500D337M016DC2A	0.374 x 0.807 [9.5 x 20.5]
470	500D477M016DD2A	0.374 x 0.945 [9.5 x 24.0]
680	500D687M016DF2A	0.374 x 1.260 [9.5 x 32.0]
1000.0 (1)	500D108M016DH2	0.374 x 1.496 [9.5 x 38.0]
1200	500D128M016DH2A	0.374 x 1.496 [9.5 x 38.0]
1200	500D128M016EF2A	0.433 x 1.260 [11.0 x 32.0]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

ELECTRICAL DATA AND ORDERING INFORMATION		
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**
16 WVDC at + 85 °C, SURGE = 20 V		
1500.0 (1)	500D158M016EH2	0.433 x 1.496 [11.0 x 38.0]
1800	500D188M016EH2A	0.433 x 1.496 [11.0 x 38.0]
1800	500D188M016FH2A	0.492 x 1.496 [12.5 x 38.0]
2200.0 (1)	500D228M016FK2	0.492 x 1.752 [12.5 x 44.5]
2700	500D278M016FK2A	0.492 x 1.752 [12.5 x 44.5]
3300	500D338M016GH2A	0.630 x 1.496 [16.0 x 38.0]
3300.0 (1)	500D338M016GK2	0.630 x 1.752 [16.0 x 44.5]
4700	500D478M016GK2A	0.630 x 1.752 [16.0 x 44.5]
5600	500D568M016LS2A	0.709 x 1.575 [18.0 x 40.0]
25 WVDC at + 85 °C, SURGE = 35 V		
22	500D226M025BA2A	0.248 x 0.512 [6.3 x 13.0]
33.0 (1)	500D336M025BB2	0.248 x 0.689 [6.3 x 17.5]
47	500D476M025BB2A	0.248 x 0.689 [6.3 x 17.5]
68	500D686M025CB2A	0.315 x 0.689 [8.0 x 17.5]
100	500D107M025CC2A	0.315 x 0.807 [8.0 x 20.5]
150.0 (1)	500D157M025DC2	0.374 x 0.807 [9.5 x 20.5]
220	500D227M025DC2A	0.374 x 0.807 [9.5 x 20.5]
330	500D337M025DD2A	0.374 x 0.945 [9.5 x 24.0]
330.0 (1)	500D337M025DF2	0.374 x 1.260 [9.5 x 32.0]
470	500D477M025DF2A	0.374 x 1.260 [9.5 x 32.0]
820	500D827M025DH2A	0.374 x 1.496 [9.5 x 38.0]
680	500D687M025EF2A	0.433 x 1.260 [11.0 x 32.0]
1000.0 (1)	500D108M025FH2	0.492 x 1.496 [12.5 x 38.0]
1200	500D128M025EH2A	0.433 x 1.496 [11.0 x 38.0]
1200	500D128M025FH2A	0.492 x 1.496 [12.5 x 38.0]
1800	500D188M025FK2A	0.492 x 1.752 [12.5 x 44.5]
1800	500D188M025GH2A	0.630 x 1.496 [16.0 x 38.0]
2200.0 (1)	500D228M025GK2	0.630 x 1.752 [16.0 x 44.5]
2700	500D278M025GK2A	0.630 x 1.752 [16.0 x 44.5]
3300	500D338M025LS2A	0.709 x 1.575 [18.0 x 40.0]
35 WVDC at + 85 °C, SURGE = 40 V		
15.0 (1)	500D156M035BA2	0.248 x 0.512 [6.3 x 13.0]
47.0 (1)	500D476M035CB2	0.315 x 0.689 [8.0 x 17.5]
330.0 (1)	500D337M035DH2	0.374 x 1.496 [9.5 x 38.0]
470.0 (1)	500D477M035EH2	0.433 x 1.496 [11.0 x 38.0]
680.0 (1)	500D687M035FK2	0.492 x 1.752 [12.5 x 44.5]
1000.0 (1)	500D108M035GH2	0.630 x 1.496 [16.0 x 38.0]
40 WVDC at + 85 °C, SURGE = 50 V		
15	500D156M040BA2A	0.248 x 0.512 [6.3 x 13.0]
22	500D226M040BB2A	0.248 x 0.689 [6.3 x 17.5]
47	500D476M040CB2A	0.315 x 0.689 [8.0 x 17.5]
68	500D686M040CC2A	0.315 x 0.807 [8.0 x 20.5]
100	500D107M040DC2A	0.374 x 0.807 [9.5 x 20.5]
180	500D187M040DD2A	0.374 x 0.945 [9.5 x 24.0]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L
40 WVDC at + 85 °C, SURGE = 50 V		
270	500D277M040DF2A	0.374 x 1.260 [9.5 x 32.0]
470	500D477M040DH2A	0.374 x 1.496 [9.5 x 38.0]
470	500D477M040EF2A	0.433 x 1.260 [11.0 x 32.0]
680	500D687M040EH2A	0.433 x 1.496 [11.0 x 38.0]
680	500D687M040FH2A	0.492 x 1.496 [12.5 x 38.0]
1000	500D108M040FK2A	0.492 x 1.752 [12.5 x 44.5]
1200	500D128M040GH2A	0.630 x 1.496 [16.0 x 38.0]
1800	500D188M040GK2A	0.630 x 1.752 [16.0 x 44.5]
2200	500D228M040LS2A	0.709 x 1.575 [18.0 x 40.0]
50 WVDC at + 85 °C, SURGE = 65 V		
10	500D106M050BA2A	0.248 x 0.512 [6.3 x 13.0]
22	500D226M050BB2A	0.248 x 0.689 [6.3 x 17.5]
33	500D336M050CB2A	0.315 x 0.689 [8.0 x 17.5]
68	500D686M050CC2A	0.315 x 0.807 [8.0 x 20.5]
100	500D107M050DC2A	0.374 x 0.807 [9.5 x 20.5]
150	500D157M050DD2A	0.374 x 0.945 [9.5 x 24.0]
220	500D227M050DF2A	0.374 x 1.260 [9.5 x 32.0]
330	500D337M050DH2A	0.374 x 1.496 [9.5 x 38.0]
330	500D337M050EF2A	0.433 x 1.260 [11.0 x 32.0]
560	500D567M050EH2A	0.433 x 1.496 [11.0 x 38.0]
470	500D477M050FH2A	0.492 x 1.496 [12.5 x 38.0]
680.0 (1)	500D687M050GH2	0.630 x 1.496 [16.0 x 38.0]
820	500D827M050FK2A	0.492 x 1.752 [12.5 x 44.5]
820	500D827M050GH2A	0.630 x 1.496 [16.0 x 38.0]
1000.0 (1)	500D108M050GK2	0.630 x 1.752 [16.0 x 44.5]
1500	500D158M050GK2A	0.630 x 1.752 [16.0 x 44.5]
1800	500D188M050LS2A	0.709 x 1.575 [18.0 x 40.0]
63 WVDC at + 85 °C, SURGE = 75 V		
6.8	500D685M063BA2A	0.248 x 0.512 [6.3 x 13.0]
15	500D156M063BB2A	0.248 x 0.689 [6.3 x 17.5]
22.0 (1)	500D226M063CB2	0.315 x 0.689 [8.0 x 17.5]
33	500D336M063CB2A	0.315 x 0.689 [8.0 x 17.5]
47	500D476M063CC2A	0.315 x 0.807 [8.0 x 20.5]
68	500D686M063DC2A	0.374 x 0.807 [9.5 x 20.5]
100	500D107M063DD2A	0.374 x 0.945 [9.5 x 24.0]
150	500D157M063DF2A	0.374 x 1.260 [9.5 x 32.0]
220.0 (1)	500D227M063DH2	0.374 x 1.496 [9.5 x 38.0]
220	500D227M063EF2A	0.433 x 1.260 [11.0 x 32.0]
270	500D277M063DH2A	0.374 x 1.496 [9.5 x 38.0]
390	500D397M063FH2A	0.492 x 1.496 [12.5 x 38.0]
470	500D477M063EH2A	0.433 x 1.496 [11.0 x 38.0]
470.0 (1)	500D477M063FK2	0.492 x 1.752 [12.5 x 44.5]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

ELECTRICAL DATA AND ORDERING INFORMATION		
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**
63 WVDC at + 85 °C, SURGE = 75 V		
560	500D567M063FK2A	0.492 x 1.752 [12.5 x 44.5]
560	500D567M063GH2A	0.630 x 1.496 [16.0 x 38.0]
1000	500D108M063GK2A	0.630 x 1.752 [16.0 x 44.5]
1200	500D128M063LS2A	0.709 x 1.575 [18.0 x 40.0]
80 WVDC at + 85 °C, SURGE = 100 V		
4.7 (1)	500D475M080BA2	0.248 x 0.512 [6.3 x 13.0]
47.0 (1)	500D476M080DC2	0.374 x 0.807 [9.5 x 20.5]
100 WVDC at + 85 °C, SURGE = 125 V		
1.0 (1)	500D105M100BA2	0.248 x 0.512 [6.3 x 13.0]
2.2 (1)	500D225M100BA2	0.248 x 0.512 [6.3 x 13.0]
3.3	500D335M100BA2A	0.248 x 0.512 [6.3 x 13.0]
4.7	500D475M100BB2A	0.248 x 0.689 [6.3 x 17.5]
10	500D106M100CB2A	0.315 x 0.689 [8.0 x 17.5]
15	500D156M100CC2A	0.315 x 0.807 [8.0 x 20.5]
22	500D226M100DC2A	0.374 x 0.807 [9.5 x 20.5]
33.0 (1)	500D336M100DD2	0.374 x 0.945 [9.5 x 24.0]
39	500D396M100DD2A	0.374 x 0.945 [9.5 x 24.0]
47.0 (1)	500D476M100DF2	0.374 x 1.260 [9.5 x 32.0]
56	500D566M100DF2A	0.374 x 1.260 [9.5 x 32.0]
100	500D107M100DH2A	0.374 x 1.496 [9.5 x 38.0]
100	500D107M100EF2A	0.433 x 1.260 [11.0 x 32.0]
100.0 (1)	500D107M100EH2	0.433 x 1.496 [11.0 x 38.0]
150	500D157M100EH2A	0.433 x 1.496 [11.0 x 38.0]
150	500D157M100FH2A	0.492 x 1.496 [12.5 x 38.0]
220	500D227M100FK2A	0.492 x 1.752 [12.5 x 44.5]
220	500D227M100GH2A	0.630 x 1.496 [16.0 x 38.0]
220.0 (1)	500D227M100GK2	0.630 x 1.752 [16.0 x 44.5]
390	500D397M100GK2A	0.630 x 1.752 [16.0 x 44.5]
470	500D477M100LS2A	0.709 x 1.575 [18.0 x 40.0]
150 WVDC at + 85 °C, SURGE = 175 V		
1.0 (1)	500D105M150BA2	0.248 x 0.512 [6.3 x 13.0]
10.0 (1)	500D106M150DC2	0.374 x 0.807 [9.5 x 20.5]
22.0 (1)	500D226M150DF2	0.374 x 1.260 [9.5 x 32.0]
33.0 (1)	500D336M150EF2	0.433 x 1.260 [11.0 x 32.0]
47.0 (1)	500D476M150EH2	0.433 x 1.496 [11.0 x 38.0]
160 WVDC at + 85 °C, SURGE = 180 V		
1.5	500D155M160BA2A	0.248 x 0.512 [6.3 x 13.0]
2.7	500D275M160BB2A	0.248 x 0.689 [6.3 x 17.5]
3.3	500D335M160CB2A	0.315 x 0.689 [8.0 x 17.5]
6.8	500D685M160CC2A	0.315 x 0.807 [8.0 x 20.5]
10	500D106M160DC2A	0.374 x 0.807 [9.5 x 20.5]
15	500D156M160DD2A	0.374 x 0.945 [9.5 x 24.0]
22	500D226M160DF2A	0.374 x 1.260 [9.5 x 32.0]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L
160 WVDC at + 85 °C, SURGE = 180 V		
27	500D276M160DH2A	0.374 x 1.496 [9.5 x 38.0]
33	500D336M160EF2A	0.433 x 1.260 [11.0 x 32.0]
47	500D476M160EH2A	0.433 x 1.496 [11.0 x 38.0]
47	500D476M160FH2A	0.492 x 1.496 [12.5 x 38.0]
56	500D566M160FK2A	0.492 x 1.752 [12.5 x 44.5]
82	500D826M160GH2A	0.630 x 1.496 [16.0 x 38.0]
100	500D107M160GK2A	0.630 x 1.752 [16.0 x 44.5]
120	500D127M160LS2A	0.709 x 1.575 [18.0 x 40.0]
200 WVDC at + 85 °C, SURGE = 250 V		
1.2	500D125M200BA2A	0.248 x 0.512 [6.3 x 13.0]
2.2	500D225M200BB2A	0.248 x 0.689 [6.3 x 17.5]
2.2 (1)	500D225M200CB2	0.315 x 0.689 [8.0 x 17.5]
2.7	500D275M200CB2A	0.315 x 0.689 [8.0 x 17.5]
3.3 (1)	500D335M200CC2	0.315 x 0.807 [8.0 x 20.5]
4.7	500D475M200CC2A	0.315 x 0.807 [8.0 x 20.5]
8.2	500D825M200DC2A	0.374 x 0.807 [9.5 x 20.5]
10	500D106M200DD2A	0.374 x 0.945 [9.5 x 24.0]
15	500D156M200DF2A	0.374 x 1.260 [9.5 x 32.0]
22	500D226M200DH2A	0.374 x 1.496 [9.5 x 38.0]
27	500D276M200EF2A	0.433 x 1.260 [11.0 x 32.0]
33	500D336M200EH2A	0.433 x 1.496 [11.0 x 38.0]
33.0 (1)	500D336M200FK2	0.492 x 1.752 [12.5 x 44.5]
39	500D396M200FH2A	0.492 x 1.496 [12.5 x 38.0]
47	500D476M200FK2A	0.492 x 1.752 [12.5 x 44.5]
68	500D686M200GH2A	0.630 x 1.496 [16.0 x 38.0]
82	500D826M200GK2A	0.630 x 1.752 [16.0 x 44.5]
100	500D107M200LS2A	0.709 x 1.575 [18.0 x 40.0]
250 WVDC at + 85 °C, SURGE = 300 V		
1	500D105M250BA2A	0.248 x 0.512 [6.3 x 13.0]
1.5 (1)	500D155M250CB2	0.315 x 0.689 [8.0 x 17.5]
1.8	500D185M250BB2A	0.248 x 0.689 [6.3 x 17.5]
2.2	500D225M250CB2A	0.315 x 0.689 [8.0 x 17.5]
2.2 (1)	500D225M250CC2	0.315 x 0.807 [8.0 x 20.5]
3.3	500D335M250CC2A	0.315 x 0.807 [8.0 x 20.5]
4.7 (1)	500D475M250DC2	0.374 x 0.807 [9.5 x 20.5]
6.8	500D685M250DC2A	0.374 x 0.807 [9.5 x 20.5]
8.2	500D825M250DD2A	0.374 x 0.945 [9.5 x 24.0]
10.0 (1)	500D106M250DF2	0.374 x 1.260 [9.5 x 32.0]
12	500D126M250DF2A	0.374 x 1.260 [9.5 x 32.0]
15.0 (1)	500D156M250EF2	0.433 x 1.260 [11.0 x 32.0]
18	500D186M250DH2A	0.374 x 1.496 [9.5 x 38.0]
18	500D186M250EF2A	0.433 x 1.260 [11.0 x 32.0]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

ELECTRICAL DATA AND ORDERING INFORMATION		
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**
250 WVDC at + 85 °C, SURGE = 300 V		
22.0 (1)	500D226M250EH2	0.433 x 1.496 [11.0 x 38.0]
27	500D276M250EH2A	0.433 x 1.496 [11.0 x 38.0]
27	500D276M250FH2A	0.492 x 1.496 [12.5 x 38.0]
39	500D396M250FK2A	0.492 x 1.752 [12.5 x 44.5]
47	500D476M250GH2A	0.630 x 1.496 [16.0 x 38.0]
47.0 (1)	500D476M250GK2	0.630 x 1.752 [16.0 x 44.5]
56	500D566M250GK2A	0.630 x 1.752 [16.0 x 44.5]
82	500D826M250LS2A	0.709 x 1.575 [18.0 x 40.0]
350 WVDC at + 85 °C, SURGE = 400 V		
0.47	500D474M350BA2A	0.248 x 0.512 [6.3 x 13.0]
0.82	500D824M350BB2A	0.248 x 0.689 [6.3 x 17.5]
1.0 (1)	500D105M350CB2	0.315 x 0.689 [8.0 x 17.5]
1.2	500D125M350CB2A	0.315 x 0.689 [8.0 x 17.5]
1.8	500D185M350CC2A	0.315 x 0.807 [8.0 x 20.5]
2.2 (1)	500D225M350DC2	0.374 x 0.807 [9.5 x 20.5]
3.3	500D335M350DC2A	0.374 x 0.807 [9.5 x 20.5]
3.9	500D395M350DD2A	0.374 x 0.945 [9.5 x 24.0]
4.7 (1)	500D475M350DF2	0.374 x 1.260 [9.5 x 32.0]
5.6	500D565M350DF2A	0.374 x 1.260 [9.5 x 32.0]
8.2	500D825M350DH2A	0.374 x 1.496 [9.5 x 38.0]
10	500D106M350EF2A	0.433 x 1.260 [11.0 x 32.0]
10.0 (1)	500D106M350EH2	0.433 x 1.496 [11.0 x 38.0]
12	500D126M350EH2A	0.433 x 1.496 [11.0 x 38.0]
15	500D156M350FH2A	0.492 x 1.496 [12.5 x 38.0]
18	500D186M350FK2A	0.492 x 1.752 [12.5 x 44.5]
22	500D226M350GH2A	0.630 x 1.496 [16.0 x 38.0]
33	500D336M350GK2A	0.630 x 1.752 [16.0 x 44.5]
39	500D396M350LS2A	0.709 x 1.575 [18.0 x 40.0]
400 WVDC at + 85 °C, SURGE = 450 V		
0.27	500D274M400BA2A	0.248 x 0.512 [6.3 x 13.0]
0.56	500D564M400BB2A	0.248 x 0.689 [6.3 x 17.5]
0.68	500D684M400CB2A	0.315 x 0.689 [8.0 x 17.5]
1	500D105M400CC2A	0.315 x 0.807 [8.0 x 20.5]
1.5 (1)	500D155M400DC2	0.374 x 0.807 [9.5 x 20.5]
2.2	500D225M400DC2A	0.374 x 0.807 [9.5 x 20.5]
2.7	500D275M400DD2A	0.374 x 0.945 [9.5 x 24.0]
3.9	500D395M400DF2A	0.374 x 1.260 [9.5 x 32.0]
5.6	500D565M400DH2A	0.374 x 1.496 [9.5 x 38.0]
6.8	500D685M400EF2A	0.433 x 1.260 [11.0 x 32.0]
10	500D106M400EH2A	0.433 x 1.496 [11.0 x 38.0]
10.0 (1)	500D106M400FK2	0.492 x 1.752 [12.5 x 44.5]
12	500D126M400FH2A	0.492 x 1.496 [12.5 x 38.0]
15	500D156M400FK2A	0.492 x 1.752 [12.5 x 44.5]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

ELECTRICAL DATA AND ORDERING INFORMATION		
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**
400 WVDC at + 85 °C, SURGE = 450 V		
18	500D186M400GH2A	0.630 x 1.496 [16.0 x 38.0]
22	500D226M400GK2A	0.630 x 1.752 [16.0 x 44.5]
39	500D396M400LS2A	0.709 x 1.575 [18.0 x 40.0]
450 WVDC at + 85 °C, SURGE = 500 V		
0.22	500D224M450BA2A	0.248 x 0.512 [6.3 x 13.0]
0.47	500D474M450BB2A	0.248 x 0.689 [6.3 x 17.5]
0.56	500D564M450CB2A	0.315 x 0.689 [8.0 x 17.5]
0.82	500D824M450CC2A	0.315 x 0.807 [8.0 x 20.5]
1.0 (1)	500D105M450DC2	0.374 x 0.807 [9.5 x 20.5]
1.8	500D185M450DC2A	0.374 x 0.807 [9.5 x 20.5]
2.2	500D225M450DD2A	0.374 x 0.945 [9.5 x 24.0]
2.2 (1)	500D225M450DF2	0.374 x 1.260 [9.5 x 32.0]
3.3	500D335M450DF2A	0.374 x 1.260 [9.5 x 32.0]
4.7	500D475M450DH2A	0.374 x 1.496 [9.5 x 38.0]
5.6	500D565M450EF2A	0.433 x 1.260 [11.0 x 32.0]
8.2	500D825M450EH2A	0.433 x 1.496 [11.0 x 38.0]
10	500D106M450FH2A	0.492 x 1.496 [12.5 x 38.0]
10.0 (1)	500D106M450GK2	0.630 x 1.752 [16.0 x 44.5]
12	500D126M450FK2A	0.492 x 1.752 [12.5 x 44.5]
15	500D156M450GH2A	0.630 x 1.496 [16.0 x 38.0]
18	500D186M450GK2A	0.630 x 1.752 [16.0 x 44.5]
33	500D336M450LS2A	0.709 x 1.575 [18.0 x 40.0]

Note

(1) Original part numbers not recommended for new equipment designs. For epoxy end seal, change “2” designation to “5”. “5” is not normally stocked

Aluminum Capacitors + 85 °C , Miniature, Axial Lead

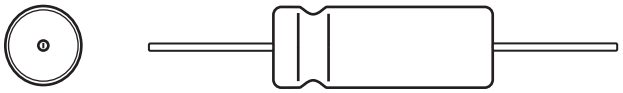


Fig.1 Component outline

FEATURES

- High CV per case size
- Low cost
- Solvent resistant construction (through 100 WVDC)

Pb-free

e3

RoHS COMPLIANT

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.197" x 0.472" [5.0 x 12.0] to 0.709" x 1.614" [18.0 x 41.0]
Operating temperature	- 40 °C to + 85 °C (- 25 °C to + 85 °C for 315 WVDC - 450 WVDC units)
Rated Capacitance range, C_R	0.47 µF to 10 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 WVDC to 450 WVDC
Termination	2 axial leads
Life validation test at 85 °C	2000 h: ΔCAP ≤ 20 % from initial measurement. ΔDF x 2 initial specified limit. ΔDCL ≤ initial specified limit.
Shelf life at 85 °C	1000 h: Δ CAP ± 20 % from initial measurement. ΔDF 2 x initial specified limit. ΔDCL ≤ the initial specified limit.
DC leakage current	rated voltage for 1 min for 6.3 WVDC to 100 WVDC units I < 0.03 CV or 4 µA (whichever is greater) rated voltage for 2 min for 6.3 WVDC to 100 WVDC units I < 0.01 CV or 3 µA (whichever is greater) rated voltage for 1 min for 160 WVDC to 450 WVDC units I < 0.1 CV + 40 µA and CV ≤ 1000 I < 0.04 CV + 100 µA and CV > 1000

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE	
Ambient Temperature	Multipliers
≤ + 70 °C	1.27
+ 85 °C	1.0

FREQUENCY (Hz)/CAPACITANCE (µF)						
WVDC	Cap. (µF)	50 to 60	100 to 120	300 to 400	1 kHz	≤ 10 kHz
6.3 to 100	0 to 47	0.75	1	1.35	1.57	2.00
	100 to 470	0.80	1	1.23	1.34	1.50
	1000 to 10 000	0.85	1	1.10	1.13	1.15
160 to 450	1 to 100	0.80	1	1.25	1.40	1.60

LOW TEMPERATURE PERFORMANCE

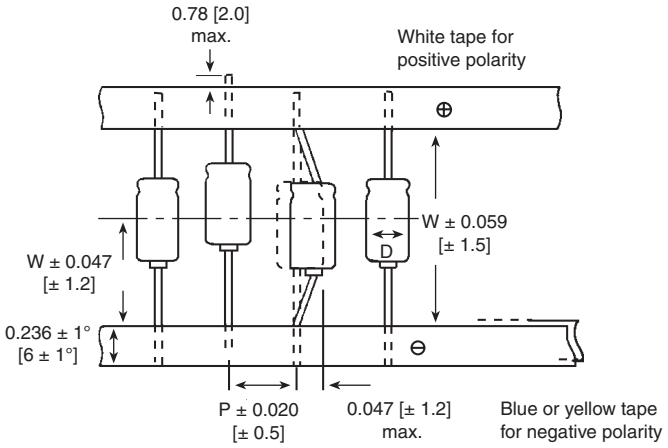
MAXIMUM IMPEDANCE RATIO $Z^{(T)}/Z^{(+ 20\ °C)}$ MAXIMUM AT 120 Hz

Rated Voltage (WVDC)	Z - 25 °C/Z + 20 °C	Z - 40 °C/Z + 20 °C
6.3	4.0	10.0
10.0	3.0	8.0
16.0	2.0	6.0
25.0	2.0	4.0
35.0 to 100.0	2.0	3.0
160.0 to 250.0	4.0	12.0
315.0 to 350.0	6.0	-
400.0 to 450.0	15.0	-

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL CASE SIZE D x L	LEAD DIAMETER	TYPICAL WEIGHT (g)	CASE CODE	NOMINAL CASE SIZE D x L	LEAD DIAMETER	TYPICAL WEIGHT (g)
JL	0.197 x .472 [5.0 x 12.0]	0.024 [0.6]	0.56	NR	0.394 x 0.984 [10.0 x 25.0]	0.024 [0.6]	3.10
LL	0.248 x .472 [6.3 x 12.0]	0.024 [0.6]	0.74	PR	0.512 x 1.023 [13.0 x 26.0]	0.024 [0.6]	4.63
LM	0.248 x .472 [6.3 x 12.0]	0.024 [0.6]	0.91	PS	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	5.47
MM	0.315 x .630 [8.0 x 16.0]	0.024 [0.6]	1.00	QS	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	8.26
MN	0.315 x .787 [8.0 x 20.0]	0.024 [0.6]	1.70	QT	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	10.42
NP	0.394 x .827 [10.0 x 21.0]	0.024 [0.6]	2.32	RT	0.709 x 1.614 [18.0 x 41.0]	0.031 [0.8]	12.42

DIMENSIONS in inches [millimeters]



DIMENSIONS in inches [millimeters] AND PACKAGING QUANTITIES				
CASE CODE	TAPING CODE	SPECIFICATIONS		
		TAPE WIDTH W ± 0.059 [1.5]	COMPONENT PITCH P ± 0.020 [0.5]	QUANTITY PER REEL
JL	B	2.063 [52.4]	0.394 [10.0]	1600
LL	B	2.063 [52.4]	0.394 [10.0]	1300
LM	B	2.063 [52.4]	0.394 [10.0]	1300
MM	B	2.063 [52.4]	0.394 [10.0]	1000
MN	B	2.500 [63.5]	0.394 [10.0]	1000
NP	B	2.500 [63.5]	0.591 [15.0]	500
NP	C	2.874 [73.0]	0.591 [15.0]	500
NR	B	2.500 [63.5]	0.591 [15.0]	500
NR	C	2.874 [73.0]	0.591 [15.0]	500
PR	B	2.500 [63.5]	0.591 [15.0]	350
PR	C	2.874 [73.0]	0.591 [15.0]	350
PS	B	2.874 [73.0]	0.591 [15.0]	350

ORDERING EXAMPLE

Electrolytic capacitor 516D series: 516D 107 M 6R3 JL 6 A E3

DESCRIPTION	
CODE	EXPLANATION
516D	product type
107	capacitance value (100 µF)
M	tolerance (M = ± 20 %)
6R3	voltage rating at 85 °C (6R3 = 6.3 V)
JL	can size (see dimensions table)
6	packaging (bulk)
A	lead style (uncut)
E3	RoHS compliant indicator

PACKING AND LEAD STYLES:

6A	Bulk, uncut leads
7B	Tape and reel. For case codes JL, LL, LM, MM, MN, NP, NR, PR and PS only.
7C	Tape and reel with 2.874" [73.0] mm tape width. For case codes NP, NR and PR only.

* Suffix E3 denotes lead (Pb)-free/RoHS compliant products

ELECTRICAL DATA AND ORDERING INFORMATION					
CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	LEAD DIAMETER	MAX. DF AT + 20 °C 120 Hz	MAX. RIPPLE AT + 85 °C/120 Hz (mA_{rms})
6.3 WVDC at + 85 °C, SURGE = 8 V					
100	516D107M6R3JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.24	110
220	516D227M6R3LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.24	200
330	516D337M6R3LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.24	250
470	516D477M6R3MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.24	330
1000	516D108M6R3NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.24	600
2200	516D228M6R3PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.24	1020
3300	516D338M6R3PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.24	1200
4700	516D478M6R3QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.024 [0.6]	0.24	1500
6800	516D688M6R3QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.24	1840
10 000	516D109M6R3QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.24	2260
10 WVDC at + 85 °C, SURGE = 13 V					
33	516D336M010JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.2	65
47	516D476M010JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.2	80
100	516D107M010LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.2	130
220	516D227M010LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.2	210
330	516D337M010MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	300
470	516D477M010MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	350
1000	516D108M010NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.2	640
2200	516D228M010PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.2	1090
3300	516D338M010PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.2	1390
4700	516D478M010QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.2	1730
6800	516D688M010QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.2	1930
10 000	516D109M010RT6AE3	0.709 x 1.614 [18.0 x 41.0]	0.031 [0.8]	0.2	2350
16 WVDC at + 85 °C, SURGE = 20 V					
22	516D226M016JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.16	60
33	516D336M016JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.16	70
47	516D476M016JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.16	85
100	516D107M016LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.16	160
220	516D227M016MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.16	260
330	516D337M016MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.16	320
470	516D477M016MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.16	430
1000	516D108M016NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.16	770
2200	516D228M016PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.16	1180
3300	516D338M016QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.16	1620
4700	516D478M016QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.16	1840
6800	516D688M016RT6AE3	0.709 x 1.614 [18.0 x 41.0]	0.031 [0.8]	0.16	2310
25 WVDC at + 85 °C, SURGE = 32 V					
10.0	516D106M025JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.14	40
22	516D226M025JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.14	65
33	516D336M025JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.14	80
47	516D476M025LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.14	100
100	516D107M025LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.14	170
220	516D227M025MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.14	280
330	516D337M025MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.14	380
470	516D477M025NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.14	510
1000	516D108M025PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.14	900

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	LEAD DIAMETER	MAX. DF AT + 20 °C 120 Hz	MAX. RIPPLE AT + 85 °C/120 Hz (mA_{rms})
25 WVDC at + 85 °C, SURGE = 32 V					
2200	516D228M025QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.14	1480
3300	516D338M025QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.14	1710
4700	516D478M025RT6AE3	0.709 x 1.614 [18.0 x 41.0]	0.031 [0.8]	0.14	2170
35 WVDC at + 85 °C, SURGE = 44 V					
10	516D106M035JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.12	45
22	516D226M035JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.12	70
33	516D336M035LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.12	90
47	516D476M035LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.12	120
100	516D107M035MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.12	210
220	516D227M035MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.12	340
330	516D337M035NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.12	460
470	516D477M035NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.12	610
1000	516D108M035PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.12	1060
2200	516D228M035QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.12	1580
3300	516D338M035QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.12	2050
50 WVDC at + 85 °C, SURGE = 63 V					
0.47	516D474M050JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.1	5
1.0	516D105M050JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.1	10
2.2	516D225M050JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.1	23
3.3	516D335M050JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.1	28
4.7	516D475M050JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.1	34
10	516D106M050JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.1	50
22	516D226M050LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.1	85
33	516D336M050LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.1	110
47	516D476M050LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.1	130
100	516D107M050MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.1	220
220	516D227M050NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.1	410
330	516D337M050NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.1	560
470	516D477M050PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.8]	0.1	730
1000	516D108M050QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.1	1260
2200	516D228M050RT6AE3	0.709 x 1.614 [18.0 x 41.0]	0.031 [0.8]	0.1	1920
63 WVDC at + 85 °C, SURGE = 79 V					
3.3	516D335M063JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	31
4.7	516D475M063JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	37
10	516D106M063JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	55
22	516D226M063LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.08	90
33	516D336M063LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.08	120
47	516D476M063MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.08	160
100	516D107M063MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.08	260
220	516D227M063NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.08	480
330	516D337M063PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.08	650
470	516D477M063PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.08	840
1000	516D108M063QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.08	1330

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	LEAD DIAMETER	MAX. DF AT + 20 °C 120 Hz	MAX. RIPPLE AT + 85 °C/120 Hz (mA_{rms})
100 WVDC at + 85 °C, SURGE = 125 V					
0.47	516D474M100JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	10
1.0	516D105M100JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	18
2.2	516D225M100JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	28
3.3	516D335M100JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	34
4.7	516D475M100JL6AE3	0.197 x 0.472 [5.0 x 12.0]	0.024 [0.6]	0.08	40
10	516D106M100LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.08	60
22	516D226M100MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.08	120
33	516D336M100MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.08	150
47	516D476M100MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.08	190
100	516D107M100NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.08	340
220	516D227M100PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.08	560
330	516D337M100PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.08	750
470	516D477M100QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.08	970
160 WVDC at + 85 °C, SURGE = 200 V					
1.0	516D105M160LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.2	13
2.2	516D225M160LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.2	23
3.3	516D335M160MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	33
4.7	516D475M160MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	39
10	516D106M160MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.2	60
22	516D226M160NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.2	120
33	516D336M160PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.2	170
47	516D476M160PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.2	230
100	516D107M160QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.2	430
200 WVDC at + 85 °C, SURGE = 250 V					
1.0	516D105M200LL6AE3	0.248 x 0.472 [6.3 x 12.0]	0.024 [0.6]	0.2	13
2.2	516D225M200LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.2	23
3.3	516D335M200MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	33
4.7	516D475M200MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	39
10	516D106M200NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.2	70
22	516D226M200PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.2	140
33	516D336M200PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.2	170
47	516D476M200PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.2	230
100	516D107M200QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.2	430
250 WVDC at + 85 °C, SURGE = 300 V					
1.0	516D105M250LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.2	14
2.2	516D225M250MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	27
3.3	516D335M250MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	33
4.7	516D475M250MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.2	45
10	516D106M250NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.2	70
22	516D226M250PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.2	140
33	516D336M250PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.2	190
47	516D476M250QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.2	260
100	516D107M250QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.2	430

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	LEAD DIAMETER	MAX. DF AT + 20 °C 120 Hz	MAX. RIPPLE AT + 85 °C/120 Hz (mA_{rms})
315 WVDC at + 85 °C, SURGE = 365 V					
1.0	516D105M315LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.2	14
2.2	516D225M315MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.2	27
3.3	516D335M315MN6AE3	0.315 x .0787 [8.0 x 20.0]	0.024 [0.6]	0.2	36
4.7	516D475M315MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.2	45
10	516D106M315NR6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.2	80
22	516D226M315PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.2	150
33	516D336M315QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.2	210
47	516D476M315QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.2	260
350 WVDC at + 85 °C, SURGE = 400 V					
1.0	516D105M350LM6AE3	0.248 x 0.630 [6.3 x 16.0]	0.024 [0.6]	0.25	12
2.2	516D225M350MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.25	24
3.3	516D335M350MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.25	32
4.7	516D475M350NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.25	46
10	516D106M350PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.25	85
22	516D226M350PS6AE3	0.512 x 1.240 [13.0 x 31.5]	0.024 [0.6]	0.25	140
33	516D336M350QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.25	190
47	516D476M350QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.25	260
400 WVDC at + 85 °C, SURGE = 450 V					
1.0	516D105M400MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.25	14
2.2	516D225M400MN6AE3	0.315 x 0.787 [8.0 x 20.0]	0.024 [0.6]	0.25	28
3.3	516D335M400NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.25	38
4.7	516D475M400NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.25	46
10	516D106M400PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.25	85
22	516D226M400QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.25	150
33	516D336M400QT6AE3	0.630 x 1.633 [16.0 x 41.5]	0.031 [0.8]	0.25	210
47	516D476M400RT6AE3	0.709 x 1.614 [18.0 x 41.0]	0.031 [0.8]	0.25	290
450 WVDC at + 85 °C, SURGE = 500 V					
1.0	516D105M450MM6AE3	0.315 x 0.630 [8.0 x 16.0]	0.024 [0.6]	0.25	14
2.2	516D225M450MN6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.25	31
3.3	516D335M450NP6AE3	0.394 x 0.827 [10.0 x 21.0]	0.024 [0.6]	0.25	38
4.7	516D475M450NP6AE3	0.394 x 1.024 [10.0 x 26.0]	0.024 [0.6]	0.25	50
10	516D106M450PR6AE3	0.512 x 1.024 [13.0 x 26.0]	0.024 [0.6]	0.25	85
22	516D226M450QS6AE3	0.630 x 1.240 [16.0 x 31.5]	0.031 [0.8]	0.25	150
33	516D336M450QT6AE3	0.709 x 1.614 [18.0 x 41.0]	0.031 [0.8]	0.25	230

Aluminum Capacitors
Little-Lytic® Electrolytics

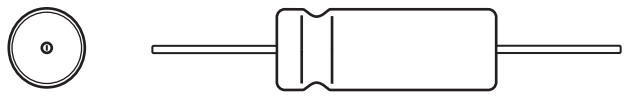


Fig.1 Component outlines

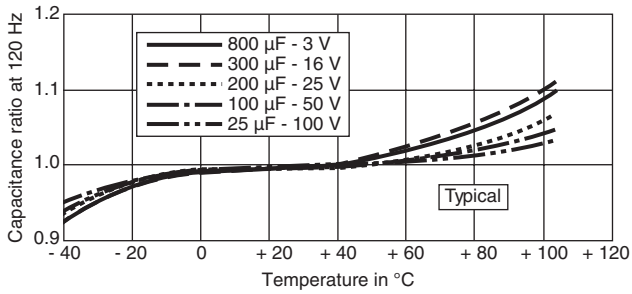
QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Operating temperature	- 40 °C to + 105 °C
Tolerance on C_R	+ 75 %, - 10 % and + 50 %, - 10 %
Ripple current	10 Ω to 600 Ω max. at 120 Hz, depending upon capacitance
Life validation test 2000 hours at + 85 °C	After test, capacitance value shall not have changed by more than ± 20 %, the equivalent series resistance in ohms shall not have exceeded 150 % of initial requirement and the leakage current shall not have exceeded the initial requirement
DC leakage current	Maximum DC leakage current at + 25 °C for all capacitors is 15 µA, except units in case code DD, which is 15.8 µA
Shelf test 250 hours at + 85 °C, with no voltage applied	The capacitance and equivalent series resistance shall meet the initial requirements and the DC leakage current shall not exceed 300 % of the initial requirement

FEATURES

Pb-free Available

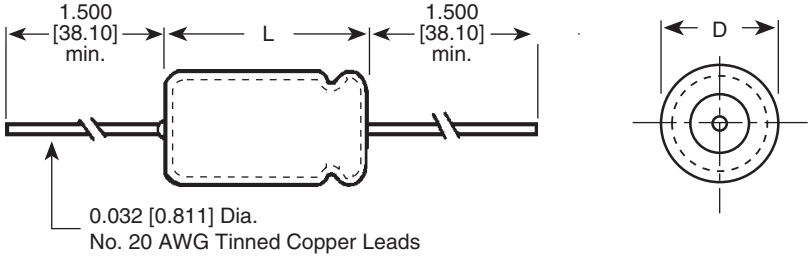
- Proven dependable performance in the industrial and electronic equipment with either transistor or modified electron-tube circuits
- All terminal connections welded, eliminating possibility of open" or intermittent contacts occasionally found in pressure joints of conventional capacitors
- Superior in size, performance characteristics, shelf life, construction and reliability
- Metal-encased with clear plastic outer insulating sleeve
- Excellent circuit performance when used as coupling capacitors
- Minimum drain and long battery life when used in battery bypass applications
- Better performance under life test than most miniature aluminum electrolytic capacitors

CAPACITANCE VS. TEMPERATURE



DIMENSIONS in inches [millimeters]					
CASE CODE	**D**	**L**	**CASE CODE**	**D**	**L**
BA	0.260 [6.604]	0.536 [13.614]	DC	0.385 [9.779]	0.848 [21.539]
BB	0.260 [6.604]	0.723 [18.364]	DD	0.385 [9.779]	0.973 [24.714]
CB	0.322 [8.179]	0.723 [18.364]	DF	0.385 [9.779]	1.286 [32.664]
CC	0.322 [8.179]	0.848 [21.539]	DH	0.385 [9.779]	1.536 [39.014]
DB	0.385 [9.779]	0.723 [18.364]			

DIMENSIONS AND AVAILABLE FORMS



ORDERING EXAMPLE

Order by distribution part no. Example: TE1055

Note
For lead (Pb)-free/RoHS compliant products add the suffix "-E3" to the shortened Distribution part. no.

Example TE1055-E3

Note
For lead (Pb)-free/RoHS compliant products add the suffix "E3" to the standard OEM part no.

Example: 30D256G003BA2E3

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	DISTRIBUTOR DIVISION PART NUMBER	SPRAGUE O.E.M. PART NUMBER
0 - 3 WVDC			
1.0	-	See 0 - 50 WVDC listing	-
2.0	-	See 0 - 50 WVDC listing	-
3.0	-	See 0 - 50 WVDC listing	-
4.0	-	See 0 - 50 WVDC listing	-
5.0	-	See 0 - 25 WVDC listing	-
6.0	-	See 0 - 25 WVDC listing	-
8.0	-	See 0 - 25 WVDC listing	-
10.0	-	See 0 - 16 WVDC llisting	-
15.0	-	See 0 - 12 WVDC listing	-
20.0	-	See 0 - 6 WVDC listing	-
25.0	BA	TE1055	30D256G003BA2
50.0	-	See 0 - 6 WVDC listing	-
75.0	-	See 0 - 6 WVDC listing	-
100.0	CB	TE1059.5	30D107G003CB2
200.0	CC	TE1064	30D207G003CC2
300.0	DC	TE1066	30D307G003DC2
500.0	DF	TE1068	30D507G003DF2
0 - 6 WVDC			
1.0	-	See 0 - 50 WVDC listing	-
2.0	-	See 0 - 50 WVDC listing	-
3.0	-	See 0 - 50 WVDC listing	-
4.0	-	See 0 - 50 WVDC listing	-
5.0	-	See 0 - 25 WVDC listing	-
6.0	-	See 0 - 25 WVDC listing	-
8.0	-	See 0 - 25 WVDC listing	-
10.0	-	See 0 - 16 WVDC listing	-
15.0	-	See 0 - 12 WVDC listing	-
20.0	BA	TE1090	30D206G006BA2
25.0	-	See 0 - 16 WVDC listing	-
35.0	BB	TE1093	30D356G006BB2
50.0	BB	TE1100	30D506G006BB2
75.0	CB	TE1101.5	30D756G006CB2
100.0	-	See 0 - 12 WVDC listing	-
200.0	DC	TE1104	30D207G006DC2
250.0	DD	TE1105	30D257G006DD2
300.0	DD	TE1106	30D307G006DD2
400.0	DF	TE1107	30D407G006DF2
500.0	DH	TE1107.5	30D507G006DH2
600.0	DH	TE1108.5	30D607G006DH2

STANDARD RATINGS			
CAPACITANCE (µF)	**CASE CODE**	**DISTRIBUTOR DIVISION PART NUMBER**	**SPRAGUE O.E.M. PART NUMBER**
0 - 12 WVDC			
1.0	-	See 0 - 50 WVDC listing	-
2.0	-	See 0 - 50 WVDC listing	-
3.0	-	See 0 - 50 WVDC listing	-
4.0	-	See 0 - 50 WVDC listing	-
5.0	-	See 0 - 25 WVDC listing	-
6.0	-	See 0 - 25 WVDC listing	-
8.0	-	See 0 - 25 WVDC listing	-
10.0	-	See 0 - 16 WVDC listing	-
15.0	BA	TE1129	30D156G012BA2
20.0	-	See 0 - 16 WVDC listing	-
25.0	-	See 0 - 16 WVDC listing	-
50.0	-	See 0 - 16 WVDC listing	-
60.0	CB	TE1133.5	30D606G012CB2
75.0	-	See 0 - 16 WVDC listing	-
100.0	CC	TE1135	30D107G012CC2
150.0	-	See 0 - 16 WVDC listing	—
200.0	-	See 0 - 16 WVDC listing	—
250.0	-	See 0 - 16 WVDC listing	—
290.0	DF	TE1139	30D297G012DF2
0 - 16 WVDC			
1.0	-	See 0 - 50 WVDC listing	-
2.0	-	See 0 - 50 WVDC listing	-
3.0	-	See 0 - 50 WVDC listing	-
4.0	-	See 0 - 50 WVDC listing	-
5.0	-	See 0 - 25 WVDC listing	-
6.0	-	See 0 - 25 WVDC listing	-
8.0	-	See 0 - 25 WVDC listing	-
10.0	BA	TE1155	30D106G016BA2
15.0	-	See 0 - 25 WVDC listing	-
20.0	BB	TE1157	30D206G016BB2
25.0	BB	TE1157.1	30D256G016BB2
30.0	-	See 0 - 25 WVDC listing	-
35.0	-	See 0 - 25 WVDC listing	-
50.0	CB	TE1160	30D506G016CB2
75.0	CC	TE1161	30D756G016CC2
100.0	DC	TE1162	30D107G016DC2
150.0	DD	TE1163	30D157G016DD2
200.0	DF	TE1164	30D207G016DF2
250.0	DF	TE1164.5	30D257G016DF2
300.0	DH	TE1165.5	30D307G016DH2
350.0	DH	TE1166	30D357G016DH2

STANDARD RATINGS

CAPACITANCE (µF)	CASE CODE	DISTRIBUTOR DIVISION PART NUMBER	SPRAGUE O.E.M. PART NUMBER
0 - 25 WVDC			
1.0	-	See 0 - 50 WVDC listing	-
2.0	-	See 0 - 50 WVDC listing	-
3.0	-	See 0 - 50 WVDC listing	-
4.0	-	See 0 - 50 WVDC listing	-
5.0	BA	TE1202	30D505G025BA2
6.0	BA	TE1203	30D605G025BA2
8.0	BA	TE1203.5	30D805G025BA2
10.0	BB	TE1204	30D106G025BB2
15.0	BB	TE1205	30D156G025BB2
20.0	CB	TE1206	30D206G025CB2
25.0	CB	TE1207	30D256G025CB2
30.0	CB	TE1207.5	30D306G025CB2
35.0	CB	TE1208	30D356G025CB2
50.0	CC	TE1209	30D506G025CC2
75.0	DC	TE1210	30D756G025DC2
100.0	DD	TE1211	30D107G025DD2
150.0	DF	TE1212	30D157G025DF2
200.0	DH	TE1213	30D207G025DH2
0 - 50 WVDC			
1.0	BA	TE1300	30D105G050BA2
2.0	BA	TE1301	30D205G050BA2
3.0	BA	TE1302	30D305G050BA2
4.0	BA	TE1302.1	30D405G050BA2
5.0	BB	TE1303	30D505G050BB2
6.0	BB	TE1303.1	30D605G050BB2
8.0	BB	TE1303.3	30D805G050BB2
10.0	CB	TE1304	30D106G050CB2
15.0	CB	TE1304.2	30D156G050CB2
20.0	CC	TE1305	30D206G050CC2
25.0	CC	TE1305.5	30D256G050CC2
35.0	DC	TE1306	30D356G050DC2
50.0	DD	TE1307	30D506G050DD2
75.0	DF	TE1308	30D756G050DF2
100.0	DH	TE1309	30D107G050DH2
100 WVDC			
1.0	BA	TE1400	30D105F100BA2
2.0	BB	TE1401	30D205F100BB2
3.0	CB	TE1402	30D305F100CB2
4.0	CB	TE1403	30D405F100CB2
5.0	CC	TE1404	30D505F100CC2
10.0	DC	TE1407	30D106F100DC2
15.0	DD	TE1408	30D156F100DD2
20.0	DF	TE1409	30D206F100DF2
25.0	DH	TE1410	30D256F100DH2
30.0	DH	TE1411	30D306F100DH2
150 WVDC			
1.0	BA	TE1500	30D105F150BA2
2.0	BB	TE1501	30D205F150BB2
3.0	CB	TE1502	30D305F150CB2
4.0	CC	TE1503	30D405F150CC2
5.0	CC	TE1504	30D505F150CC2
8.0	DC	TE1506	30D805F150DC2
10.0	DD	TE1507	30D106F150DD2
15.0	DF	TE1508.1	30D156F150DF2
20.0	DH	TE1509	30D206F150DH2

Aluminum Capacitors
+ 105 °C, Tubular, Axial Lead

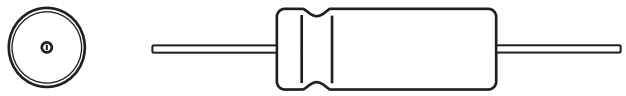


Fig.1 Component outlines

FEATURES

- Temperature range - 55 °C to + 105 °C
- Long life
- Low ESR
- Available on special order - Call Vishay representative for part numbers and specifications

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.625" x 1.125" [15.875 x 28.575] to 1.0" x 3.625" [25.4 x 92.075]
Operating temperature	- 55 °C to + 105 °C
Rated Capacitance range, C_R	12 µF to 33 000 µF
Tolerance on C_R	- 10 %, + 50 %
Rated voltage range, U_R	6.3 WVDC to 300 WVDC
Termination	Axial leads
Life validation test at 105 °C	2000 hours: Δ CAP ≤ 15 % from initial measurement. Δ ESR ≤ 1.25 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at 105 °C	500 hours: Δ CAP ≤ 10 % from initial measurement. Δ ESR ≤ 1.15 x initial specified limit. Δ DCL ≤ 2.0 x initial specified limit.
DC leakage current	$I = K\sqrt{CV}$ K = 0.5 at + 25 °C; = 3.0 at + 105 °C I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE			
Ambient Temperature	Multipliers		
+ 105 °C	0.4		
+ 65 °C	1.4		
+ 45 °C	1.7		
+ 25 °C	2.0		
FREQUENCY (Hz)			
WVDC	50 - 60	300 - 400	1000 AND UP
0 - 60	0.85	1.10	1.15
61 - 250	0.83	1.15	1.20

LOW TEMPERATURE PERFORMANCE

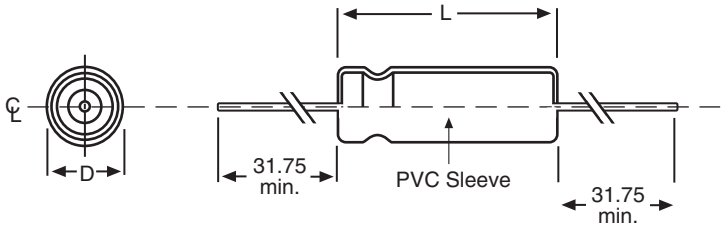
CAPACITANCE RATIO $C_{-55\,°C}/C_{+25\,°C}$ MINIMUM at 120 Hz	
Rated Voltage WVDC	Capacitance Remaining
0 - 25	75
26 - 100	80
101 - 250	85
ESR RATIO $ESR_{-55\,°C}/ESR_{+25\,°C}$ MAXIMUM at 120 Hz	
Rated Voltage WVDC	Multiplier
0 - 9	10
10 - 40	12
41 - 250	18

DIMENSIONS in inches [millimeters]

CASE CODE	STYLE 1 AND 2 INSULATING SLEEVE		STYLE 5 AND 7 INSULATING SLEEVE, COATED END SEAL		TYPICAL WEIGHT
	D	L	D	L	
FE	0.635 ± 0.020 [16.1 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.57]	0.635 ± 0.020 [16.1 ± 0.51]	1.187 ± 0.062 [30.2 ± 1.57]	0.32 oz. (9.0 g)
FJ	0.635 ± 0.020 [16.1 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.57]	0.635 ± 0.020 [16.1 ± 0.51]	1.687 ± 0.062 [42.9 ± 1.57]	0.39 oz. (11.0 g)
FL	0.635 ± 0.020 [16.1 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.57]	0.635 ± 0.020 [16.1 ± 0.51]	2.187 ± 0.062 [55.6 ± 1.57]	0.53 oz. (15.0 g)
FP	0.635 ± 0.020 [16.1 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.57]	0.635 ± 0.020 [16.1 ± 0.51]	2.687 ± 0.062 [68.3 ± 1.57]	0.63 oz. (18.0 g)
FS	0.635 ± 0.020 [16.1 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.57]	0.635 ± 0.020 [16.1 ± 0.51]	3.187 ± 0.062 [81.0 ± 1.57]	0.88 oz. (25.0 g)
FT	0.635 ± 0.020 [16.1 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.57]	0.635 ± 0.020 [16.1 ± 0.51]	3.687 ± 0.062 [93.7 ± 1.57]	0.98 oz. (28.0 g)
GE	0.760 ± 0.020 [19.3 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.57]	0.760 ± 0.020 [19.3 ± 0.51]	1.187 ± 0.062 [30.2 ± 1.57]	0.46 oz. (13.0 g)
GJ	0.760 ± 0.020 [19.3 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.57]	0.760 ± 0.020 [19.3 ± 0.51]	1.687 ± 0.062 [42.9 ± 1.57]	0.67 oz. (19.0 g)

DIMENSIONS in inches [millimeters]					
CASE CODE	**STYLE 1 AND 2 INSULATING SLEEVE**		**STYLE 5 AND 7 INSULATING SLEEVE, COATED END SEAL**		**TYPICAL WEIGHT**
	D	**L**	**D**	**L**	
GL	0.760 ± 0.020 [19.3 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.57]	0.760 ± 0.020 [19.3 ± 0.51]	2.187 ± 0.062 [55.6 ± 1.57]	0.74 oz. (21.0 g)
GP	0.760 ± 0.020 [19.3 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.57]	0.760 ± 0.020 [19.3 ± 0.51]	2.687 ± 0.062 [68.3 ± 1.57]	0.88 oz. (25.0 g)
GS	0.760 ± 0.020 [19.3 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.57]	0.760 ± 0.020 [19.3 ± 0.51]	3.187 ± 0.062 [81.0 ± 1.57]	1.16 oz. (33.0 g)
GT	0.760 ± 0.020 [19.3 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.57]	0.760 ± 0.020 [19.3 ± 0.51]	3.687 ± 0.062 [93.7 ± 1.57]	1.33 oz. (38.0 g)
HE	0.885 ± 0.020 [22.5 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.57]	0.885 ± 0.020 [22.5 ± 0.51]	1.187 ± 0.062 [30.2 ± 1.57]	0.63 oz. (18.0 g)
HJ	0.885 ± 0.020 [22.5 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.57]	0.885 ± 0.020 [22.5 ± 0.51]	1.687 ± 0.062 [42.9 ± 1.57]	0.95 oz. (27.0 g)
HL	0.885 ± 0.020 [22.5 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.57]	0.885 ± 0.020 [22.5 ± 0.51]	2.187 ± 0.062 [55.6 ± 1.57]	1.02 oz. (29.0 g)
HP	0.885 ± 0.020 [22.5 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.57]	0.885 ± 0.020 [22.5 ± 0.51]	2.687 ± 0.062 [68.3 ± 1.57]	1.37 oz. (39.0 g)
HS	0.885 ± 0.020 [22.5 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.57]	0.885 ± 0.020 [22.5 ± 0.51]	3.187 ± 0.062 [81.0 ± 1.57]	1.72 oz. (49.0 g)
HT	0.885 ± 0.020 [22.5 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.57]	0.885 ± 0.020 [22.5 ± 0.51]	3.687 ± 0.062 [93.7 ± 1.57]	2.07 oz. (59.0 g)
JE	1.010 ± 0.020 [25.7 ± 0.51]	1.141 ± 0.062 [29.0 ± 1.57]	1.010 ± 0.020 [25.7 ± 0.51]	1.187 ± 0.062 [30.2 ± 1.57]	0.81 oz. (23.0 g)
JJ	1.010 ± 0.020 [25.7 ± 0.51]	1.641 ± 0.062 [41.7 ± 1.57]	1.010 ± 0.020 [25.7 ± 0.51]	1.687 ± 0.062 [42.9 ± 1.57]	1.02 oz. (29.0 g)
JL	1.010 ± 0.020 [25.7 ± 0.51]	2.141 ± 0.062 [54.4 ± 1.57]	1.010 ± 0.020 [25.7 ± 0.51]	2.187 ± 0.062 [55.5 ± 1.57]	1.54 oz. (44.0 g)
JP	1.010 ± 0.020 [25.7 ± 0.51]	2.641 ± 0.062 [67.1 ± 1.57]	1.010 ± 0.020 [25.7 ± 0.51]	2.687 ± 0.062 [68.3 ± 1.57]	1.86 oz. (53.0 g)
JS	1.010 ± 0.020 [25.7 ± 0.51]	3.141 ± 0.062 [79.8 ± 1.57]	1.010 ± 0.020 [25.7 ± 0.51]	3.187 ± 0.062 [81.0 ± 1.57]	2.21 oz. (63.0 g)
JT	1.010 ± 0.020 [25.7 ± 0.51]	3.641 ± 0.062 [92.5 ± 1.57]	1.010 ± 0.020 [25.7 ± 0.51]	3.687 ± 0.062 [93.7 ± 1.57]	2.52 oz. (72.0 g)

DIMENSIONS AND AVAILABLE FORMS



ORDERING EXAMPLE

Electrolytic capacitor 601D series: 601D 158 F 050 GL 1

DESCRIPTION	
CODE	**EXPLANATION**
601D	product type
158	capacitance value (1500 µF)
F	tolerance (F = - 10 %/+ 50 %)
050	voltage rating at 105 °C (050 = 50 V)
GL	can size (see Dimensions table)
1	sleeve and sealing (1 = P.V.C. sleeve)

Aluminum Capacitors
4-Terminal, Tubular, Axial Lead

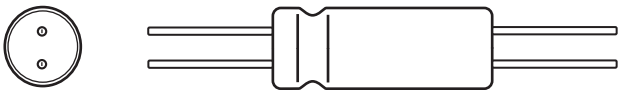


Fig.1 Component outlines

FEATURES

- 4-Terminal construction
- Very low impedance
- Inductance limit 2 nH
- Wide temperature range
- Available on special order - Call Buy/Resale Division for part numbers and specifications

Pb-free Available

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	20.625 x 46.812 to 26.975 x 97.612
Operating temperature	- 55 °C to + 105 °C
Rated capacitance range, C_R	47 µF to 22 000 µF
Tolerance on C_R	- 10 %, + 50 %
Rated voltage range, U_R	5 WVDC to 200 WVDC
Termination	4-terminal
Life validation test 2000 hours at 105 °C	Δ CAP ± 15 % from initial measurement. Δ ESR < 1.5 x initial specified limit. Δ DCL < initial specified limit.
Shelf life 500 hours at 105 °C	500 hours: C < 10 % from initial measurement. Δ ESR < 1.2 x initial specified limit. Δ DCL < 2.0 x initial specified limit.
DC leakage current $I = K\sqrt{CV}$	K is a constant: 0.5 at - 25 °C, 3.0 at + 105 °C I in µA, C in µF, V in Volts

LOW TEMPERATURE PERFORMANCE	
CAPACITANCE RATIO $C^{-55\,°C}/C^{+25\,°C}$ MINIMUM at 120 Hz	
RATED VOLTAGE WVDC	**CAPACITANCE REMAINING**
5 - 50	75 %
51 - up	80 %
ESR RATIO $ESR^{-55\,°C}/ESR^{+25\,°C}$ MAXIMUM at 120 Hz	
Rated Voltage WVDC	**Multiplier**
5 - 50	12
51 - up	18

RIPPLE CURRENT MULTIPLIERS

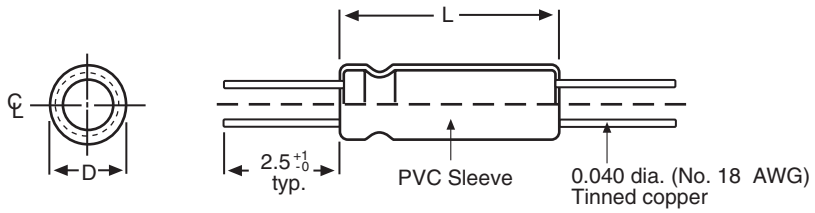
For ripple current values contact the factory.

DIMENSIONS in millimeters

CASE CODE	BARE CASE		OUTER INSULATION WITH POLYMER COATED END SEALS		LEAD SPACING
	D	L	D	L (max.)	S
GJ	19.050 ± 0.787	41.275 ± 1.575	20.625 ± 0.787	46.812	6.350 ± 0.381
GL	19.050 ± 0.787	53.975 ± 1.575	20.625 ± 0.787	59.512	6.350 ± 0.381
GP	19.050 ± 0.787	66.675 ± 1.575	20.625 ± 0.787	72.212	6.350 ± 0.381
GS	19.050 ± 0.787	79.375 ± 1.575	20.625 ± 0.787	84.912	6.350 ± 0.381
GT	19.050 ± 0.787	92.075 ± 1.575	20.625 ± 0.787	97.612	6.350 ± 0.381
HJ	22.225 ± 0.787	28.575 ± 1.575	23.800 ± 0.787	34.112	7.620 ± 0.381
HL	22.225 ± 0.787	66.675 ± 1.575	23.800 ± 0.787	72.212	7.620 ± 0.381
HP	22.225 ± 0.787	53.975 ± 1.575	23.800 ± 0.787	59.512	7.620 ± 0.381
HS	22.225 ± 0.787	92.075 ± 1.575	23.800 ± 0.787	97.612	7.620 ± 0.381
HT	22.225 ± 0.787	79.375 ± 1.575	23.800 ± 0.787	84.912	7.620 ± 0.381

DIMENSIONS in millimeters					
CASE CODE	**BARE CASE**		**OUTER INSULATION WITH POLYMER COATED END SEALS**		**LEAD SPACING**
	D	**L**	**D**	**L (max.)**	**S**
JJ	25.400 ± 0.787	41.275 ± 1.575	26.975 ± 0.787	46.812	10.160 ± 0.381
JL	25.400 ± 0.787	53.975 ± 1.575	26.975 ± 0.787	59.512	10.160 ± 0.381
JP	25.400 ± 0.787	66.675 ± 1.575	26.975 ± 0.787	72.212	10.160 ± 0.381
JS	25.400 ± 0.787	79.375 ± 1.575	26.975 ± 0.787	84.912	10.160 ± 0.381
JT	25.400 ± 0.787	92.075 ± 1.575	26.975 ± 0.787	97.612	10.160 ± 0.381

DIMENSIONS AND AVAILABLE FORMS



$\frac{0.040}{1.016}$ Diameter (No. 18 AWG) - Case diameter G,H, J

ORDERING EXAMPLE

Electrolytic capacitor 604D series: 604D 272 F 005 GJ 7

DESCRIPTION	
CODE	**EXPLANATION**
604D	product type
272	capacitance value (2700 µF)
F	tolerance (F= - 10 %/± 50 %)
005	voltage rating at 85 °C (005 = 5 V)
GJ	can size
7	sleeve and sealing (7 = pvc sleeve w/epoxy end seal)

Aluminum Capacitors
+ 105 °C, Miniature, Axial Lead, General Purpose

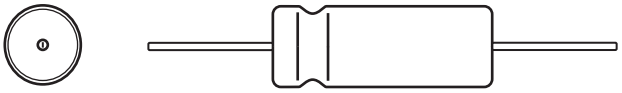


Fig.1 Component outline

FEATURES

- Long life
- High performance
- High CV per case size
- Case sizes to 0.709" [18.0 mm] diameters

Pb-free Available

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	0.248" x 0.512" [6.3 x 13.0] to 0.709" x 1.574" [18.0 x 40.0]
Operating temperature	- 40 °C to + 105 °C
Rated capacitance range, C_R	1 µF to 4700 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	3 WVDC to 250 WVDC
Termination	axial leads
Life validation test at 105 °C	2000 hours: Δ CAP ≤ 20 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at 85 °C	500 hours: Δ CAP ≤ 20 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ 2.0 x initial specified limit.
DC leakage current	3 WVDC to 16 WVDC: $I = 0.1\sqrt{CV} + 2$ 25 WVDC to 250 WVDC: $I = 0.2\sqrt{CV} + 2$ I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS				
TEMPERATURE				
AMBIENT TEMPERATURE	**MULTIPLIERS**			
+ 105 °C	0.5			
+ 85 °C	1.0			
≤ 65 °C	2.0			
FREQUENCY (Hz)				
WVDC	**50 - 60**	**100 - 120**	**300 - 400**	**1K - 100K**
3 - 50	0.9	1.0	1.1	1.4
51 - 250	0.8	1.0	1.3	1.6

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL		STYLE 2		STYLE 5 RESIN END SEAL APPLIED	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)
BA	0.248 [6.300]	0.512 [13.000]	0.276 [7.000]	0.567 [14.400]	0.276 [7.000]	0.626 [15.900]
BB	0.248 [6.300]	0.689 [17.500]	0.276 [7.000]	0.756 [19.200]	0.276 [7.000]	0.815 [20.700]
CB	0.315 [8.000]	0.689 [17.500]	0.339 [8.600]	0.756 [19.200]	0.339 [8.600]	0.815 [20.700]
CC	0.315 [8.000]	0.807 [20.500]	0.339 [8.600]	0.878 [22.300]	0.339 [8.600]	0.937 [23.800]
DC	0.374 [9.500]	0.807 [20.500]	0.402 [10.200]	0.878 [22.300]	0.402 [10.200]	0.937 [23.800]
DD	0.374 [9.500]	0.945 [24.000]	0.402 [10.200]	1.01 [25.500]	0.402 [10.200]	1.063 [27.000]
DF	0.374 [9.500]	1.260 [32.000]	0.402 [10.200]	1.319 [33.500]	0.402 [10.200]	1.378 [35.000]
DH	0.374 [9.500]	1.496 [38.000]	0.402 [10.200]	1.567 [39.800]	0.402 [10.200]	1.626 [41.300]
EF	0.433 [11.000]	1.260 [32.000]	0.465 [11.800]	1.319 [33.500]	0.465 [11.800]	1.378 [35.000]
EH	0.433 [11.000]	1.496 [38.000]	0.465 [11.800]	1.567 [39.800]	0.465 [11.800]	1.626 [41.300]
FH	0.492 [12.500]	1.496 [38.000]	0.516 [13.100]	1.567 [39.800]	0.516 [13.100]	1.626 [41.300]
FK	0.492 [12.500]	1.752 [44.500]	0.516 [13.100]	1.831 [46.500]	0.516 [13.100]	1.890 [48.000]
GH	0.630 [16.000]	1.496 [38.000]	0.654 [16.600]	1.567 [39.800]	0.654 [16.600]	1.626 [41.300]
GK	0.630 [16.000]	1.752 [44.500]	0.654 [16.600]	1.831 [46.500]	0.654 [16.600]	1.890 [48.000]
LS	0.709 [18.000]	1.575 [40.000]	0.736 [18.700]	1.673 [42.500]	0.736 [18.700]	1.693 [43.000]

ORDERING EXAMPLE

Electrolytic capacitor 30D series: 30D 128 M 025 EH 2 A

DESCRIPTION	
CODE	**EXPLANATION**
30D	product type
128	capacitance value (1200 µF)
M	tolerance (M = ± 20 %)
025	voltage rating at 105 °C (024 = 25 V)
EH	can size (see dimensions table)
2	sleeve and sealing (2 = P. V. C. sleeve)
A	packaging (A = bulk)

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L [mm]	MAX. ESR at + 25 °C 120 Hz (Ω)	MAX. RIPPLE at + 85 °C 120 Hz (A)
6.3 WVDC at + 105 °C, SURGE = 8 V				
150.0	30D157M6R3BB2A	0.248 x 0.689 [6.3 x 17.5]	2.875	0.163
330.0	30D337M6R3CC2A	0.315 x 0.807 [8.0 x 20.5]	1.277	0.299
1200.0	30D128M6R3DF2A	0.374 x 1.260 [9.5 x 32.0]	0.345	0.767
2200.0	30D228M6R3EF2A	0.433 x 1.260 [11.0 x 32.0]	0.206	1.080
4700.0	30D478M6R3GH2A	0.630 x 1.496 [16.0 x 38.0]	0.118	1.910
10 WVDC at + 105 °C, SURGE = 12 V				
47.0	30D476M010BA2A	0.248 x 0.512 [6.3 x 13.0]	7.487	0.089
100.0	30D107M010BB2A	0.248 x 0.689 [6.3 x 17.5]	3.561	0.147
330.0	30D337M010CC2A	0.315 x 0.807 [8.0 x 20.5]	1.081	0.325
470.0	30D477M010DC2A	0.374 x 0.807 [9.5 x 20.5]	0.748	0.434
1000.0	30D108M010DF2A	0.374 x 1.260 [9.5 x 32.0]	0.356	0.755
2200.0	30D228M010EH2A	0.433 x 1.496 [11.0 x 38.0]	0.184	1.240
16 WVDC at + 105 °C, SURGE = 20 V				
33.0	30D336M016BA2A	0.248 x 0.512 [6.3 x 13.0]	9.814	0.078
150.0	30D157M016CB2A	0.315 x 0.689 [8.0 x 17.5]	2.208	0.212
330.0	30D337M016DC2A	0.374 x 0.807 [9.5 x 20.5]	1.981	0.379
470.0	30D477M016DD2A	0.374 x 0.945 [9.5 x 24.0]	0.679	0.483
1200.0	30D128M016DH2A	0.374 x 1.496 [9.5 x 38.0]	0.265	0.947
4700.0	30D478M016GK2A	0.630 x 1.752 [16.0 x 44.5]	0.093	2.290
20 WVDC at + 105 °C, SURGE = 25 V				
150.0	30D157M020CC2A	0.315 x 0.807 [8.0 x 20.5]	2.110	0.233
220.0	30D227M020DC2A	0.374 x 0.807 [9.5 x 20.5]	1.410	0.318
1000.0	30D108M020EF2A	0.433 x 1.260 [11.0 x 32.0]	0.323	0.863
1500.0	30D158M020EH2A	0.433 x 1.496 [11.0 x 38.0]	0.221	1.140
3300.0	30D338M020GK2A	0.630 x 1.752 [16.0 x 44.5]	0.118	2.040

ELECTRICAL DATA AND ORDERING INFORMATION				
CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L [mm]	MAX. ESR at + 25 °C 120 Hz (Ω)	MAX. RIPPLE at + 85 °C 120 Hz (A)
25 WVDC at + 105 °C, SURGE = 35 V				
22.0	30D226M025BA2A	0.248 x 0.512 [6.3 x 13.0]	13.270	0.067
47.0	30D476M025BB2A	0.248 x 0.689 [6.3 x 17.5]	6.128	0.112
100.0	30D107M025CC2A	0.315 x 0.807 [8.0 x 20.5]	2.914	0.197
220.0	30D227M025DC2A	0.374 x 0.807 [9.5 x 20.5]	1.327	0.326
330.0	30D337M025DD2A	0.374 x 0.945 [9.5 x 24.0]	0.885	0.423
470.0	30D477M025DF2A	0.374 x 1.260 [9.5 x 32.0]	0.612	0.575
1200.0	30D128M025EH2A	0.433 x 1.496 [11.0 x 38.0]	0.239	1.090
3300.0	30D338M025LS2A	0.709 x 1.575 [18.0 x 40.0]	0.108	2.190
35 WVDC at + 105 °C, SURGE = 45 V				
33.0	30D336M035BB2A	0.248 x 0.689 [6.3 x 17.5]	8.330	0.096
100.0	30D107M035DC2A	0.374 x 0.807 [9.5 x 20.5]	2.740	0.212
220.0	30D227M035DD2A	0.374 x 0.945 [9.5 x 24.0]	1.250	0.356
330.0	30D337M035DF2A	0.374 x 1.260 [9.5 x 32.0]	0.830	0.495
1000.0	30D108M035EH2A	0.433 x 1.496 [11.0 x 38.0]	0.274	1.020
2200.0	30D228M035GK2A	0.630 x 1.752 [16.0 x 44.5]	0.125	1.980
40 WVDC at + 105 °C, SURGE = 50 V				
15.0	30D156M040BA2A	0.248 x 0.512 [6.3 x 13.0]	17.600	0.058
22.0	30D226M040BB2A	0.248 x 0.689 [6.3 x 17.5]	11.700	0.081
47.0	30D476M040CB2A	0.315 x 0.689 [8.0 x 17.5]	5.435	0.134
100.0	30D107M040DC2A	0.374 x 0.807 [9.5 x 20.5]	2.585	0.234
470.0	30D477M040DH2A	0.374 x 1.496 [9.5 x 38.0]	0.543	0.663
1000.0	30D108M040FK2A	0.492 x 1.752 [12.5 x 44.5]	0.258	1.210
2200.0	30D228M040LS2A	0.709 x 1.575 [18.0 x 40.0]	0.125	2.040
50 WVDC at + 105 °C, SURGE = 65 V				
10.0	30D106M050BA2A	0.248 x 0.512 [6.3 x 13.0]	25.85	0.048
22.0	30D226M050BB2A	0.248 x 0.689 [6.3 x 17.5]	11.700	0.081
33.0	30D336M050CB2A	0.315 x 0.689 [8.0 x 17.5]	7.850	0.112
100.0	30D107M050DC2A	0.374 x 0.807 [9.5 x 20.5]	2.585	0.233
220.0	30D227M050DF2A	0.374 x 1.260 [9.5 x 32.0]	1.177	0.417
330.0	30D337M050DH2A	0.374 x 1.496 [9.5 x 38.0]	0.785	0.551
1500.0	30D158M050GK2A	0.630 x 1.752 [16.0 x 44.5]	0.176	1.670
63 WVDC at + 105 °C, SURGE = 75 V				
15.0	30D156M063BB2A	0.248 x 0.689 [6.3 x 17.5]	16.580	0.068
33.0	30D336M063CB2A	0.315 x 0.689 [8.0 x 17.5]	7.370	0.116
47.0	30D476M063CC2A	0.315 x 0.807 [8.0 x 20.5]	5.100	0.149
100.0	30D107M063DD2A	0.374 x 0.945 [9.5 x 24.0]	2.426	0.256
220.0	30D227M063EF2A	0.433 x 1.260 [11.0 x 32.0]	1.105	0.467
470.0	30D477M063EH2A	0.433 x 1.496 [11.0 x 38.0]	0.510	0.745
1000.0	30D108M063GK2A	0.630 x 1.752 [16.0 x 44.5]	0.242	1.420

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L [mm]	MAX. ESR at + 25 °C 120 Hz (Ω)	MAX. RIPPLE at + 85 °C 120 Hz (A)
75 WVDC at + 105 °C, SURGE = 85 V				
12.0	30D126M075BB2A	0.248 x 0.689 [6.3 x 17.5]	13.200	0.076
47.0	30D476M075DC2A	0.374 x 0.807 [9.5 x 20.5]	3.384	0.204
120.0	30D127M075DF2A	0.374 x 1.260 [9.5 x 32.0]	1.320	0.392
1000.0	30D108M075LS2A	0.709 x 1.575 [18.0 x 40.0]	0.160	1.810
100 WVDC at + 105 °C, SURGE = 125 V				
4.7	30D475M100BB2A	0.248 x 0.689 [6.3 x 17.5]	33.840	0.048
10.0	30D106M100CB2A	0.315 x 0.689 [8.0 x 17.5]	16.097	0.079
100.0	30D107M100DH2A	0.374 x 1.496 [9.5 x 38.0]	1.609	0.386
220.0	30D227M100EK2A	0.492 x 1.752 [12.5 x 44.5]	0.733	0.717
470.0	30D477M100LS2A	0.709 x 1.575 [18.0 x 40.0]	0.338	1.240
160 WVDC at + 105 °C, SURGE = 180 V				
1.5	30D155M160BA2A	0.248 x 0.512 [6.3 x 13.0]	110.10	0.023
3.3	30D335M160CB2A	0.315 x 0.689 [8.0 x 17.5]	48.880	0.045
10.0	30D106M160DC2A	0.374 x 0.807 [9.5 x 20.5]	16.097	0.093
22.0	30D226M160DF2A	0.374 x 1.260 [9.5 x 32.0]	7.333	0.166
33.0	30D336M160EF2A	0.433 x 1.260 [11.0 x 32.0]	4.888	0.222
47.0	30D476M160EH2A	0.433 x 1.496 [11.0 x 38.0]	3.384	0.289
100.0	30D107M160GK2A	0.630 x 1.752 [16.0 x 44.5]	1.609	0.552
200 WVDC at + 105 °C, SURGE = 250 V				
1.2	30D125M200BA2A	0.248 x 0.512 [6.3 x 13.0]	132.01	0.022
4.7	30D475M200CC2A	0.315 x 0.807 [8.0 x 20.5]	33.850	0.058
8.2	30D825M200DC2A	0.374 x 0.807 [9.5 x 20.5]	19.410	0.085
10.0	30D106M200DD2A	0.374 x 0.945 [9.5 x 24.0]	16.090	0.101
22.0	30D226M200DH2A	0.374 x 1.496 [9.5 x 38.0]	7.331	0.181
33.0	30D336M200EH2A	0.433 x 1.496 [11.0 x 38.0]	4.880	0.241
47.0	30D476M200EK2A	0.492 x 1.752 [12.5 x 44.5]	3.384	0.334
100.0	30D107M200LS2A	0.709 x 1.575 [18.0 x 40.0]	1.609	0.571
250 WVDC at + 105 °C, SURGE = 300 V				
1.0	30D105M250BA2A	0.248 x 0.512 [6.3 x 13.0]	160.97	0.021
3.3	30D335M250CC2A	0.315 x 0.807 [8.0 x 20.5]	48.010	0.049
12.0	30D126M250DF2A	0.374 x 1.260 [9.5 x 32.0]	13.210	0.124
47.0	30D476M250GH2A	0.630 x 1.496 [16.0 x 38.0]	3.384	0.355

Aluminum Capacitors
+ 125 °C, Miniature, Axial Lead

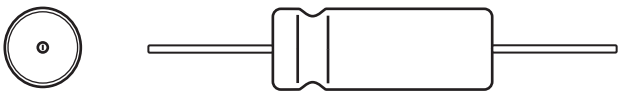


Fig.1 Component outline

FEATURES

- Extended temperature range
- Economical
- High reliability design
- For timing circuit applications
- Available on special order - Call Buy/Resale Division for part numbers and specifications
- Original 630D short numbers are inventoried

Pb-free Available

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	0.236" x 0.472" [6.0 x 12.0] to 0.472" x 1.771" [12.0 x 45.0]
Operating temperature	- 55 °C to + 125 °C
Rated capacitance range, C_R	6.8 µF to 3900 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	3 WVDC to 63 WVDC
Termination	axial leaded
Life validation test at 125 °C	500 hours: Δ CAP ≤ 20 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at 85 °C	500 hours: Δ CAP ≤ 20 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ 3 x the initial specified limit.
DC leakage current	I = 0.004 CV + 3 I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS				
TEMPERATURE				
AMBIENT TEMPERATURE	**MULTIPLIERS**			
+ 125 °C	0.5			
+ 85 °C	1.0			
+ 65 °C	2.0			
+ 55 °C or less	2.5			
FREQUENCY (Hz)				
WVDC	**50 - 60**	**100 - 120**	**300 - 400**	**> 1000**
3 - 63	0.90	1.00	1.10	1.35

DIMENSIONS in inches [millimeters]

CASE CODE	NOMINAL		STYLE 2		STYLE 5	
	D	L	D (max.)	L (max.)	D (max.)	L (max.)
BB	0.248 [6.3]	0.689 [17.5]	0.276 [7.0]	0.756 [19.2]	0.276 [7.0]	0.815 [20.7]
CB	0.315 [8.0]	0.689 [17.5]	0.339 [8.6]	0.756 [19.2]	0.339 [8.6]	0.815 [20.7]
CC	0.315 [8.0]	0.807 [20.5]	0.339 [8.6]	0.878 [22.3]	0.339 [8.6]	0.937 [23.8]
DC	0.374 [9.5]	0.807 [20.5]	0.402 [10.2]	0.878 [22.3]	0.402 [10.2]	0.937 [23.8]
DD	0.374 [9.5]	0.945 [24.0]	0.402 [10.2]	1.004 [25.5]	0.402 [10.2]	1.063 [27.0]
DF	0.374 [9.5]	1.260 [32.0]	0.402 [10.2]	1.319 [33.5]	0.402 [10.2]	1.378 [35.0]
DH	0.374 [9.5]	1.496 [38.0]	0.402 [10.2]	1.567 [39.8]	0.402 [10.2]	1.626 [41.3]
EF	0.433 [11.0]	1.260 [32.0]	0.465 [11.8]	1.319 [33.5]	0.465 [11.8]	1.378 [35.0]
EH	0.433 [11.0]	1.496 [38.0]	0.465 [11.8]	1.567 [39.8]	0.465 [11.8]	1.63 [41.3]
FH	0.492 [12.5]	1.496 [38.0]	0.516 [13.1]	1.567 [39.8]	0.516 [13.1]	1.63 [41.3]
FK	0.492 [12.5]	1.752 [44.5]	0.516 [13.1]	1.83 [46.5]	0.516 [13.1]	1.89 [48.0]

ORDERING EXAMPLE

Electrolytic capacitor 630D series: 630D 157 M 030 DF 2 A

DESCRIPTION	
CODE	**EXPLANATION**
630D	product type
157	capacitance value (150 µF)
M	tolerance (M = ± 20 %)
030	voltage rating at 125 °C (030 = 30 V)
DF	can size (see dimensions table)
2	sleeve and sealing (2 = polyester sleeve)
A	packaging (A = bulk)

Aluminum Capacitors
Miniature, Axial Lead, High Reliability

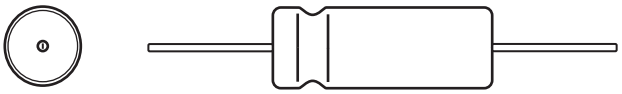


Fig.1 Component outline

FEATURES

- Wide temperature range
- Foil tantalum replacement
- Unique Teflon end seal for long life
- High vibration capability
- Life test 2000 hours at + 125 °C

Pb-free Available

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size Ø D x L in mm	0.276" x 0.945" [7.0 x 24.0] to 0.374" x 2.677" [9.5 x 68.0]
Operating temperature	- 55 °C to + 125 °C
Rated capacitance range, C_R	2.2 µF to 2700 µF
Tolerance on C_R	+ 10 %, + 50 %; - 10 %, + 75 %
Rated voltage range, U_R	5 WVDC to 250 WVDC
Termination	2 axial leads
Life validation test at 125 °C	2000 hours: Δ CAP ≤ 15 % from initial measurement. Δ ESR ≤ 1.3 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at 125 °C	500 hours: Δ CAP ≤ 10 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ 2 x the initial specified limit.
DC leakage current	0 WVDC to 75 WVDC $I = 0.15 \sqrt{CV}$ I in µA, C in µF, V in Volts 100 WVDC to 250 WVDC $I = 0.15 \sqrt{CV} + 5$

RIPPLE CURRENT MULTIPLIERS				
TEMPERATURE				
AMBIENT TEMPERATURE	**MULTIPLIERS**			
+ 125 °C	1.0			
+ 85 °C	2.0			
+ 75 °C or less	2.4			
FREQUENCY (Hz)				
WVDC	**50 - 60**	**100 - 120**	**300 - 400**	**> 1000**
0 - 30	0.85	1.0	1.04	1.08
31 - 250	0.80	1.0	1.30	1.40

DIMENSIONS in inches [millimeters]

CASE CODE	BARE CASE		WITH OUTER INSULATION	
	DIAMETER	LENGTH	DIAMETER	LENGTH (max.)
KD	0.281 ± 0.016 [7.14 ± 0.40]	0.937 ± 0.031 [23.81 ± 0.79]	0.297 ± 0.031 [7.54 ± 0.79]	1.00 [25.40]
DD	0.375 ± 0.016 [9.53 ± 0.40]	0.937 ± 0.031 [23.81 ± 0.79]	0.391 ± 0.031 [9.92 ± 0.79]	1.00 [25.40]
DE	0.375 ± 0.016 [9.53 ± 0.40]	1.125 ± 0.031 [28.58 ± 0.79]	0.391 ± 0.031 [9.92 ± 0.79]	1.187 [30.16]
DG	0.375 ± 0.016 [9.53 ± 0.40]	1.375 ± 0.031 [34.93 ± 0.79]	0.391 ± 0.031 [9.92 ± 0.79]	1.437 [36.51]
DJ	0.375 ± 0.016 [9.53 ± 0.40]	1.625 ± 0.031 [41.28 ± 0.79]	0.391 ± 0.031 [9.92 ± 0.79]	1.687 [42.86]
DL	0.375 ± 0.016 [9.53 ± 0.40]	2.187 ± 0.031 [55.56 ± 0.79]	0.391 ± 0.031 [9.92 ± 0.79]	2.249 [57.12]
DX	0.375 ± 0.016 [9.53 ± 0.40]	2.687 ± 0.031 [68.26 ± 0.79]	0.391 ± 0.031 [9.92 ± 0.79]	2.749 [69.82]

ORDERING EXAMPLE

Electrolytic capacitor 600D series: 600D 227 F 010 DE 4

DESCRIPTION	
CODE	**EXPLANATION**
600D	product type
227	capacitance value (220 µF)
F	tolerance (F = - 10 %/ + 50 %)
010	voltage rating at 85 °C (010 = 10 V)
DE	can size (see dimensions table)
4	sleeve and sealing (4 = polyester sleeve)

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. ESR at + 25 °C 120 Hz	Max. RIPPLE at + 125 °C 120 Hz
5 WVDC at + 85 °C . . . 3 WVDC at + 125 °C				
220	600D227F005KD4	0.281 x 0.937 [7.14 x 23.8]	1.75	0.127
470	600D477F005DD4	0.375 x 0.937 [9.53 x 23.8]	0.813	0.221
680	600D687F005DE4	0.375 x 1.126 [9.53 x 28.6]	0.564	0.286
1000	600D108F005DG4	0.375 x 1.378 [9.53 x 35.0]	0.388	0.377
1200	600D128F005DJ4	0.375 x 1.626 [9.53 x 41.3]	0.32	0.477
1800	600D188F005DL4	0.375 x 2.185 [9.53 x 55.5]	0.21	0.631
2700	600D278F005DX4	0.375 x 2.685 [9.53 x 68.2]	0.14	0.851
7 WVDC at + 85 °C . . . 5 WVDC at + 125 °C				
180	600D187F007KD4	0.281 x 0.937 [7.14 x 23.8]	2.121	0.115
390	600D397F007DD4	0.375 x 0.937 [9.53 x 23.8]	0.972	0.202
470	600D477F007DE4	0.375 x 1.126 [9.53 x 28.6]	0.813	0.238
680	600D687F007DG4	0.375 x 1.378 [9.53 x 35.0]	0.564	0.312
1000	600D108F007DJ4	0.375 x 1.626 [9.53 x 41.3]	0.388	0.406
1500	600D158F007DL4	0.375 x 2.185 [9.53 x 55.5]	0.26	0.567
2200	600D228F007DX4	0.375 x 2.685 [9.53 x 68.2]	0.175	0.761
10 WVDC at + 85 °C . . . 7 WVDC at + 125 °C				
120	600D127F010KD4	0.281 x 0.937 [7.14 x 23.8]	3.18	0.094
330	600D337F010DD4	0.375 x 0.937 [9.53 x 23.8]	1.16	0.185
390	600D397F010DE4	0.375 x 1.126 [9.53 x 28.6]	0.972	0.218
560	600D567F010DG4	0.375 x 1.378 [9.53 x 35.0]	0.673	0.286
820	600D827F010DJ4	0.375 x 1.626 [9.53 x 41.3]	0.46	0.373
1200	600D128F010DL4	0.375 x 2.185 [9.53 x 55.5]	0.318	0.513
1500	600D158F010DX4	0.375 x 2.685 [9.53 x 68.2]	0.23	0.664
15 WVDC at + 85 °C . . . 10 WVDC at + 125 °C				
100	600D107F015KD4	0.281 x 0.937 [7.14 x 23.8]	3.88	0.085
220	600D227F015DD4	0.375 x 0.937 [9.53 x 23.8]	1.75	0.15
330	600D337F015DE4	0.375 x 1.126 [9.53 x 28.6]	1.16	0.199
470	600D477F015DG4	0.375 x 1.378 [9.53 x 35.0]	0.813	0.26
560	600D567F015DJ4	0.375 x 1.626 [9.53 x 41.3]	0.686	0.305
820	600D827F015DL4	0.375 x 2.185 [9.53 x 55.5]	0.46	0.426
1200	600D128F015DX4	0.375 x 2.685 [9.53 x 68.2]	0.32	0.563

Notes

(1) These values are normally stocked. Other ratings are available on special request.

(2) Type 600D Original Ratings are recommended for replacement applications only.

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. ESR at + 25 °C 120 Hz	Max. RIPPLE at + 125 °C 120 Hz
20 WVDC at + 85 °C . . . 15 WVDC at + 125 °C				
68	600D686F020KD4	0.281 x 0.937 [7.14 x 23.8]	4.274	0.081
150	600D157F020DD4	0.375 x 0.937 [9.53 x 23.8]	1.962	0.142
220	600D226F020DE4	0.375 x 1.126 [9.53 x 28.6]	1.325	0.186
330	600D337F020DG4	0.375 x 1.378 [9.53 x 35.0]	0.883	0.25
390	600D397F020DJ4	0.375 x 1.626 [9.53 x 41.3]	0.257	0.299
680	600D687F020DL4	0.375 x 2.185 [9.53 x 55.5]	0.564	0.385
820	600D827F020DX4	0.375 x 2.685 [9.53 x 68.2]	0.36	0.53
30 WVDC at + 85 °C . . . 20 WVDC at + 125 °C				
47	600D476F030KD4	0.281 x 0.937 [7.14 x 23.8]	3.06	0.096
100	600D107F030DD4	0.375 x 0.937 [9.53 x 23.8]	1.50	0.162
150	600D157F030DE4	0.375 x 1.126 [9.53 x 28.6]	1.00	0.215
220	600D227F030DG4	0.375 x 1.378 [9.53 x 35.0]	0.675	0.285
270	600D277F030DJ4	0.375 x 1.626 [9.53 x 41.3]	0.56	0.338
390	600D397F030DL4	0.375 x 2.185 [9.53 x 55.5]	0.375	0.472
560	600D567F030DX4	0.375 x 2.685 [9.53 x 68.2]	0.264	0.62
40 WVDC at + 85 °C . . . 30 WVDC at + 125 °C				
33	600D336F040KD4	0.281 x 0.937 [7.14 x 23.8]	4.50	0.079
82	600D826F040DD4	0.375 x 0.937 [9.53 x 23.8]	1.824	0.147
100	600D107F040DE4	0.375 x 1.126 [9.53 x 28.6]	1.50	0.175
150	600D157F040DG4	0.375 x 1.378 [9.53 x 35.0]	1.00	0.234
180	600D187F040DJ4	0.375 x 1.626 [9.53 x 41.3]	0.844	0.275
270	600D277F040DL4	0.375 x 2.185 [9.53 x 55.5]	0.54	0.394
390	600D397F040DX4	0.375 x 2.685 [9.53 x 68.2]	0.397	0.505
50 WVDC at + 85 °C . . . 40 WVDC at + 125 °C				
22	600D226F050KD4	0.281 x 0.937 [7.14 x 23.8]	6.75	0.065
56	600D566F050DD4	0.375 x 0.937 [9.53 x 23.8]	2.65	0.122
68	600D686F050DE4	0.375 x 1.126 [9.53 x 28.6]	2.17	0.146
100.0 (1)	600D107F050DG4	0.375 x 1.378 [9.53 x 35.0]	1.50	0.192
150	600D157F050DJ4	0.375 x 1.626 [9.53 x 41.3]	1.00	0.253
180	600D187F050DL4	0.375 x 2.185 [9.53 x 55.5]	0.844	0.315
270	600D277F050DX4	0.375 x 2.685 [9.53 x 68.2]	0.54	0.433
60 WVDC at + 85 °C . . . 50 WVDC at + 125 °C				
15	600D156F060KD4	0.281 x 0.937 [7.14 x 23.8]	9.65	0.055
39	600D396F060DD4	0.375 x 0.937 [9.53 x 23.8]	3.85	0.102
47	600D476F060DE4	0.375 x 1.126 [9.53 x 28.6]	3.06	0.123
82	600D826F060DG4	0.375 x 1.378 [9.53 x 35.0]	1.82	0.174
100	600D107F060DJ4	0.375 x 1.626 [9.53 x 41.3]	1.50	0.207
150	600D157F060DL4	0.375 x 2.185 [9.53 x 55.5]	1.00	0.29
220	600D227F060DX4	0.375 x 2.685 [9.53 x 68.2]	0.675	0.388

Notes

(1) These values are normally stocked. Other ratings are available on special request.

(2) Type 600D Original Ratings are recommended for replacement applications only.

ELECTRICAL DATA AND ORDERING INFORMATION

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. ESR at + 25 °C 120 Hz	Max. RIPPLE at + 125 °C 120 Hz
75 WVDC at + 85 °C . . . 60 WVDC at + 125 °C				
12.0 (1)	600D126F075KD4	0.281 x 0.937 [7.14 x 23.8]	12.3	0.048
27	600D276F075DD4	0.375 x 0.937 [9.53 x 23.8]	5.625	0.084
39	600D396F075DE4	0.375 x 1.126 [9.53 x 28.6]	3.857	0.11
56	600D566F075DG4	0.375 x 1.378 [9.53 x 35.0]	2.64	0.144
82	600D826F075DJ4	0.375 x 1.626 [9.53 x 41.3]	1.82	0.187
120	600D127F075DL4	0.375 x 2.185 [9.53 x 55.5]	1.227	0.261
150	600D157F075DX4	0.375 x 2.685 [9.53 x 68.2]	1.00	0.399
100 WVDC at + 85 °C . . . 75 WVDC at + 125 °C				
6.8	600D685F100KD4	0.281 x 0.937 [7.14 x 23.8]	22.5	0.036
22	600D226F100DD4	0.375 x 0.937 [9.53 x 23.8]	6.75	0.077
27	600D276F100DE4	0.375 x 1.126 [9.53 x 28.6]	5.625	0.091
39	600D396F100DG4	0.375 x 1.378 [9.53 x 35.0]	3.857	0.12
56	600D566F100DJ4	0.375 x 1.626 [9.53 x 41.3]	2.64	0.156
82	600D826F100DL4	0.375 x 2.185 [9.53 x 55.5]	1.824	0.215
120	600D127F100DX4	0.375 x 2.685 [9.53 x 68.2]	1.27	0.91
150 WVDC at + 85 °C . . . 100 WVDC at + 125 °C				
3.3	600D335F150KD4	0.281 x 0.937 [7.14 x 23.8]	38.30	0.028
6.8	600D685F150DD4	0.375 x 0.937 [9.53 x 23.8]	19.16	0.046
12.0 (1)	600D126F150DE4	0.375 x 1.126 [9.53 x 28.6]	10.5	0.066
18	600D186F150DG4	0.375 x 1.378 [9.53 x 35.0]	6.85	0.09
22.0 (1)	600D226F150DJ4	0.375 x 1.626 [9.53 x 41.3]	5.75	0.106
33.0 (1)	600D336F150DL4	0.375 x 2.185 [9.53 x 55.5]	3.83	0.148
47	600D476F150DX4	0.375 x 2.685 [9.53 x 68.2]	2.61	0.197
200 WVDC at + 85 °C . . . 150 WVDC at + 125 °C				
3.3	600D335F200KD4	0.281 x 0.937 [7.14 x 23.8]	38.30	0.028
6.8	600D685F200DD4	0.375 x 0.937 [9.53 x 23.8]	19.16	0.046
8.2	600D825F200DE4	0.375 x 1.126 [9.53 x 28.6]	15.50	0.055
12	600D126F200DG4	0.375 x 1.378 [9.53 x 35.0]	10.50	0.073
18	600D186F200DJ4	0.375 x 1.626 [9.53 x 41.3]	6.78	0.098
27.0	600D276F200DL4	0.375 x 2.185 [9.53 x 55.5]	4.790	0.132
33.0	600D336F200DX4	0.375 x 2.685 [9.53 x 68.2]	3.830	0.162
250 WVDC at + 85 °C . . . 200 WVDC at + 125 °C				
2.2	600D225F250KD4	0.281 x 0.937 [7.14 x 23.8]	57.50	0.023
5.6 (1)	600D565F250DD4	0.375 x 0.937 [9.53 x 23.8]	23.10	0.042
6.8 (1)	600D685F250DE4	0.375 x 1.126 [9.53 x 28.6]	19.16	0.05
10.0 (1)	600D106F250DG4	0.375 x 1.378 [9.53 x 35.0]	12.70	0.066
15	600D156F250DJ4	0.375 x 1.626 [9.53 x 41.3]	8.23	0.088
22.0 (1)	600D226F250DL4	0.375 x 2.185 [9.53 x 55.5]	5.75	0.121
27.0 (1)	600D276F250DX4	0.375 x 2.685 [9.53 x 68.2]	4.79	0.146

Notes

(1) These values are normally stocked. Other ratings are available on special request.

(2) Type 600D Original Ratings are recommended for replacement applications only.

ELECTRICAL DATA AND ORDERING INFORMATION - original ratings [2]		
CAPACITANCE (µF)	**CASE CODE**	**PART NUMBER**
7 WVDC at + 85 °C . . . 5 WVDC at + 125 °C		
220	DD	600D227G007DD4
270	DE	600D277G007DE4
390	DG	600D397G007DG4
560	DJ	600D567G007DJ4
820	DL	600D827G007DL4
1000	DX	600D108G007DX4
10 WVDC at + 85 °C . . . 7 WVDC at + 125 °C		
100	KD	600D107G010KD4
180	DD	600D187G010DD4
220.0 [1]	DE	600D227G010DE4
330	DG	600D337G010DG4
470	DJ	600D477G010DJ4
680	DL	600D687G010DL4
820	DX	600D827G010DX4
15 WVDC at + 85 °C . . . 10 WVDC at + 125 °C		
68	KD	600D686G015KD4
82	KD	600D826G015KD4
150	DD	600D157G015DD4
180	DE	600D187G015DE4
270	DG	600D277G015DG4
390	DJ	600D397G015DJ4
560	DL	600D567G015DL4
680	DX	600D687G015DX4
20 WVDC at + 85 °C . . . 15 WVDC at + 125 °C		
68	KD	600D686G020KD4
100.0 [1]	DD	600D107G020DD4
220	DG	600D227G020DG4
30 WVDC at + 85 °C . . . 20 WVDC at + 125 °C		
33	KD	600D336G030KD4
47	KD	600D476G030KD4
82.0 [1]	DD	600D826G030DD4
100	DE	600D107G030DE4
120	DG	600D127G030DG4
150.0 [1]	DG	600D157G030DG4
220	DJ	600D227G030DJ4
330	DL	600D337G030DL4
390	DX	600D397G030DX4
40 WVDC at + 85 °C . . . 30 WVDC at + 125 °C		
50	DD	600D506G040DD4
70	DE	600D706G040DE4
100.0 [1]	DG	600D107G040DG4
140	DJ	600D147G040DJ4
210.0 [1]	DL	600D217G040DL4
50 WVDC at + 85 °C . . . 40 WVDC at + 125 °C		
22.0 [1]	KD	600D226G050KD4
33	DD	600D336G050DD4
47.0 [1]	DE	600D476G050DE4
56	DG	600D566G050DG4
68	DG	600D686G050DG4
100.0 [1]	DJ	600D107G050DJ4
150.0 [1]	DL	600D157G050DL4

Notes

[1] These values are normally stocked. Other ratings are available on special request.

[2] Type 600D Original Ratings are recommended for replacement applications only.

ELECTRICAL DATA AND ORDERING INFORMATION - original ratings [2]

CAPACITANCE (µF)	CASE CODE	PART NUMBER
60 WVDC at + 85 °C . . . 50 WVDC at + 125 °C		
17.0 [1]	KD	600D176G060KD4
80.0 [1]	DJ	600D806G060DJ4
75 WVDC at + 85 °C . . . 60 WVDC at + 125 °C		
12.0 [1]	KD	600D126F075KD4
22.0 [1]	DD	600D226F075DD4
33	DE	600D336F075DE4
47.0 [1]	DG	600D476F075DG4
68.0 [1]	DJ	600D686F075DJ4
100	DL	600D107F075DL4
120.0 [1]	DX	600D127F075DX4
100 WVDC at + 85 °C . . . 75 WVDC at + 125 °C		
8.2	KD	600D825F100KD4
12	DD	600D126F100DD4
15	DE	600D156F100DE4
22	DG	600D226F100DG4
33	DJ	600D336F100DJ4
47.0 [1]	DL	600D476F100DL4
68	DX	600D686F100DX4
150 WVDC at + 85 °C . . . 100 WVDC at + 125 °C		
4.7 [1]	KD	600D475F150KD4
5.6	KD	600D565F150KD4
8.2 [1]	DD	600D825F150DD4
12.0 [1]	DE	600D126F150DE4
18	DG	600D186F150DG4
22.0 [1]	DJ	600D226F150DJ4
33.0 [1]	DL	600D336F150DL4
56.0 [1]	DX	600D566F150DX4
200 WVDC at + 85 °C . . . 150 WVDC at + 125 °C		
3.3	KD	-
3.9	KD	-
5.6	DD	-
8	DE	600D805F200DE4
8.2	DE	-
12	DG	-
15	DJ	-
27	DL	-
39.0 [1]	DX	600D396F200DX4
250 WVDC at + 85 °C . . . 200 WVDC at + 125 °C		
2.2	KD	-
3.3	KD	600D335F250KD4
5.6 [1]	DD	600D565F250DD4
6.8 [1]	DE	600D685F250DE4
10	DG	600D106F250DG4
12.0 [1]	DJ	600D126F250DJ4
22.0 [1]	DL	600D226F250DL4
27.0 [1]	DX	600D276F250DX4

Notes

[1] These values are normally stocked. Other ratings are available on special request.

[2] Type 600D Original Ratings are recommended for replacement applications only.

Aluminum Capacitors
+ 125 °C, Non-Polar, Miniature (Specials)

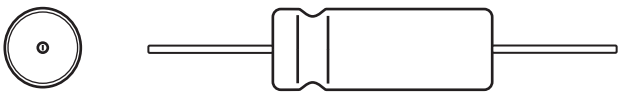


Fig.1 Component outline

FEATURES

- Extended temperature range
- Exceptional capacitance stability
- Low DF
- Low DC leakage current
- Tantalum foil replacement
- Available on special order - Contact Buy/Resale Division for part numbers and specifications

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size Ø D x L in mm	0.296" x 1.000" [7.518 x 25.40] to 0.390" x 2.812" [9.906 x 71.425]
Operating temperature	- 55 °C to + 125 °C
Rated capacitance range, C_R	0.68 µF to 680 µF
Tolerance on C_R	- 10 %, + 50 %; - 10 %, + 75 %
Rated voltage range, U_R	7 WVDC to 250 WVDC
Termination	axial leads
Life validation test at + 125 °C	2000 hours: ΔCAP < 15 % from initial measurement. ΔESR < 1.3 x initial specified limit. ΔDCL < initial specified limit.
Shelf life at + 125 °C	500 hours: ΔCAP < 10 % from initial measurement. ΔESR < 1.2 x initial specified limit. ΔDCL < 2.0 x initial specified limit.

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE				
AMBIENT TEMPERATURE			MULTIPLIERS	
+ 100 °C			1.5	
+ 85 °C			2.0	
+ 65 °C			2.5	
FREQUENCY (Hz)				
WVDC	50 - 60	100 - 120	300 - 400	> 100K
6 - 60	0.85	1.0	1.10	1.15
61 - 250	0.83	1.0	1.15	1.20

LOW TEMPERATURE PERFORMANCE

Capacitance: The maximum allowable capacitance change with temperature from + 25 °C shall be in accordance with the following:

RATED VOLTAGE AT + 125 °C	PERCENT CAPACITANCE CHANGE AT		
	- 55 °C	+ 85 °C	+ 125 °C
5 - 15	- 30	+ 15	+ 20
20 and up	- 25	+ 15	+ 20

DIMENSIONS in inches [millimeters]

CASECODE	WITH OUTER INSULATION		
	DIAMETER	LENGTH* (max.)	TYPICAL WEIGHT (g)
KD	0.297 ± 0.031 [7.54 ± 0.79]	1.000 [25.40]	1.90
DE	0.390 ± 0.031 [9.92 ± 0.79]	1.187 [30.16]	3.90
DU	0.390 ± 0.031 [9.92 ± 0.79]	1.500 [38.10]	4.90
DL	0.390 ± 0.031 [9.92 ± 0.79]	2.187 [55.56]	7.00
DR	0.390 ± 0.031 [9.92 ± 0.79]	2.812 [71.42]	8.60

Note

(1) Style 2. For style 5, increase the maximum length by 0.125" [3.18 mm].

ORDERING EXAMPLE

Electrolytic capacitor 610D series: 610D 105 F 200 KD 2

DESCRIPTION

CODE	EXPLANATION
610D	product type
105	capacitance value (1.0 µF)
F	tolerance (F = - 10 %/+ 50 %)
200	voltage rating at 85 ºC (200 = 200 V)
KD	can size (see dimensions table)
2	sleeve and sealing (2 = polyester sleeve)

Standard Series Values in a Decade for Resistance and Capacitances

E3 TO E192

According to IEC 60063

E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E24	E12	E6	E3
100	100	100	178	178	178	316	316	316	562	562	562	10	10	10	10
101			180			320			569			11			
102	102		182	182		324	324		576	576		12	12		
104			184			328			583			13			
105	105	105	187	187	187	332	332	332	590	590	590	15	15	15	
106			189			336			597			16			
107	107		191	191		340	340		604	604		18	18		
109			193			344			612			20			
110	110	110	196	196	196	348	348	348	619	619	619	22	22	22	22
111			198			352			626			24			
113	113		200	200		357	357		634	634		27	27		
114			203			361			642			30			
115	115	115	205	205	205	365	365	365	649	649	649	33	33	33	
117			208			370			657			36			
118	118		210	210		374	374		665	665		39	39		
120			213			379			673			43			
121	121	121	215	215	215	383	383	383	681	681	681	47	47	47	47
123			218			388			690			51			
124	124		221	221		392	392		698	698		56	56		
126			223			397			706			62			
127	127	127	226	226	226	402	402	402	715	715	715	68	68	68	
129			229			407			723			75			
130	130		232	232		412	412		732	732		82	82		
132			234			417			741			91			
133	133	133	237	237	237	422	422	422	750	750	750				
135			240			427			759						
137	137		243	243		432	432		768	768					
138			246			437			777						
140	140	140	249	249	249	442	442	442	787	787	787				
142			252			448			796						
143	143		255	255		453	453		806	806					
145			258			459			816						
147	147	147	261	261	261	464	464	464	825	825	825				
149			264			470			835						
150	150		267	267		475	475		845	845					
152			271			481			856						
154	154	154	274	274	274	487	487	487	866	866	866				
156			277			493			876						
158	158		280	280		499	499		887	887					
160			284			505			898						
162	162	162	287	287	287	511	511	511	909	909	909				
164			291			517			920						
165	165		294	294		523	523		931	931					
167			298			530			942						
169	169	169	301	301	301	536	536	536	953	953	953				
172			305			542			965						
174	174		309	309		549	549		976	976					
176			312			556			988						

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